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Engineering News-Record

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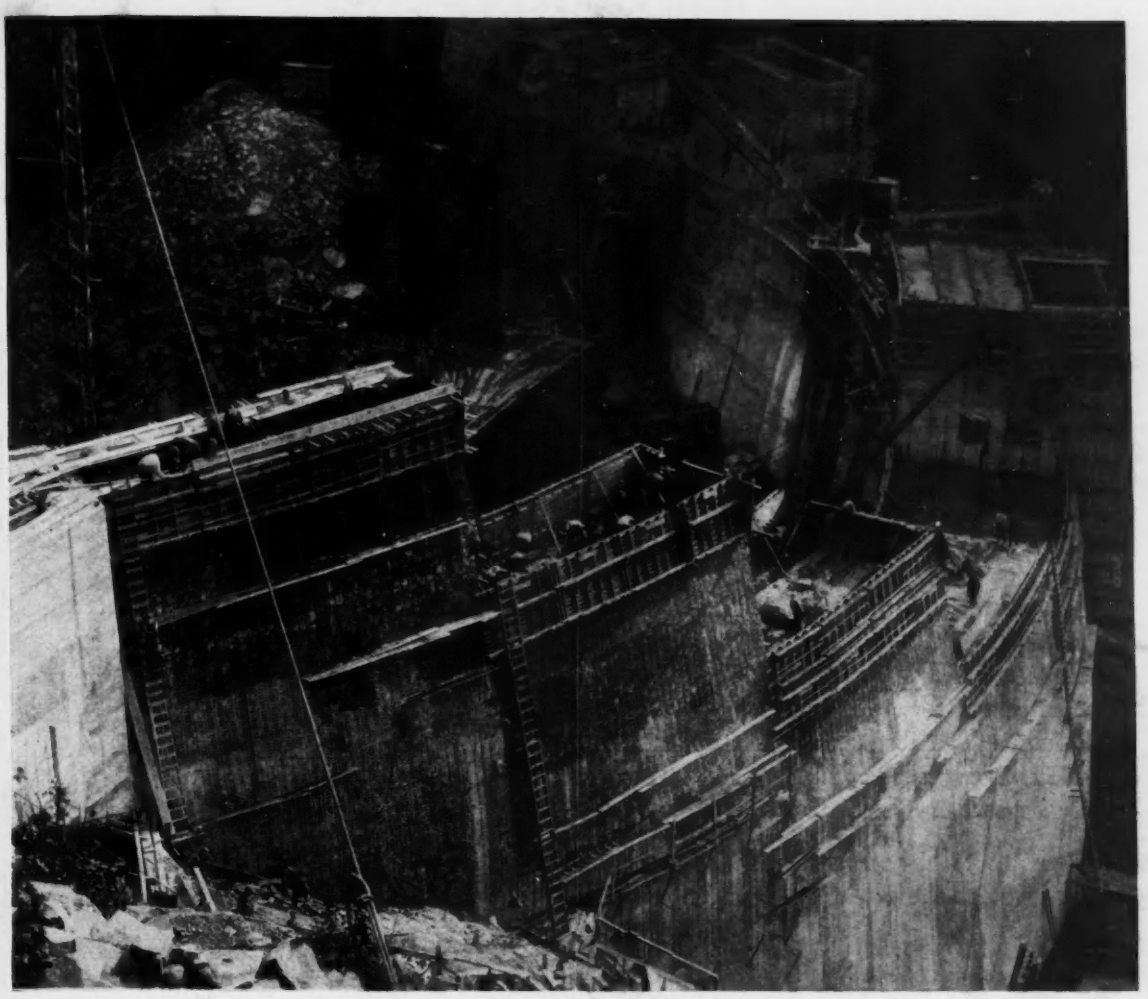

Brick-facing being laid up inside of forms on Canadea Dam

New England's First Wet-Process Cement Plant Building a Brick-Faced Concrete-Arch Dam

Mississippi River Flood-Control Plan Approved

Project for Flood Relief Adopted by Congress Meets With Approval of Board Appointed by the President to Study Differences Between Two Major Plans Proposed

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New York, August 23, 1928

Engineering News-Record

A Consolidation of Engineering News, Engineering Record, The Sanitary Engineer, and The Contractor

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Volume 101 NEW YORK, AUGUST 23, 1928 Number 8

A Pioneer City Engineer

SAMUEL A. ARTINGSTALL, whose death in Chicago early this month was announced last week in these columns, was peculiarly a local engineer. Like George H. Benzenberg, of Milwaukee, he left the impress of his engineering work chiefly on the public improvements of his home city. With E. S. Chesbrough, Samuel Greeley, Benezette Williams and Lyman E. Cooley he formed that group of early Chicago engineers which gave the Mid-Western metropolis its deserved reputation for civic public works vision. Like each of them, as his work at home became known abroad he was called into consultation on great enterprises elsewhere. But it was particularly in Chicago that Mr. Artingstall recorded his engineering accomplishments. Brought to America from England by E. S. Chesbrough, who had gone abroad for his city to study English sewerage practice, perhaps the first occasion on which an American city had sent its engineer across the ocean to learn improved methods of sanitation, Mr. Artingstall as assistant aided in the early sewerage and water-supply undertakings which were planned and carried out by Chesbrough in the early sixties. Afterward as city engineer himself he continued the drainage undertakings with which, one after another, Chicago struggled until the planning of the Drainage Canal, to keep its river clean and its water supply uncontaminated. As its chief engineer for a period he had a part in planning the great main channel which reversed the flow of a river and gave cleanliness and health to a city. Few now remain of the engineers who saw and took part in so much of Chicago's sanitary development. When Mr. Artingstall came to America there was no such thing as the systematic sewerage of cities in this country. When a few years ago, under the burden of years, he ceased active work, a protected water supply and a sewerage system had become the possession of almost every town and village and sewage-works were becoming the rule. In his own city he played a capable part in this sanitary progress. Chicago has reason to be grateful for the labors of this pioneer city engineer.

Settling St. Francis Dam Claims

UNUSUAL if not unprecedented in the annals of the failure of engineering structures was the immediate assumption by the city of Los Angeles of not only rehabilitation work in the path of destruction that followed the failure of the St. Francis dam, last March, but also the payment of damages for property and for loss of life. The organization effected for this purpose and the methods being followed under which damage claims at the rate of $250,000 a week are being settled are outlined in our news section this week. So far as we know this is the first instance on record of voluntary assumption of damages and setting up machinery to pay them after a great disaster. As between damages for property and those due to death and to personal injury, settlement for the former seems to be much the simpler, partly because determination of the facts is relatively easy in the case of such tangible things as property compared with the more intangible values resulting from loss of life and personal injury. True, the courts for many decades, if not centuries, and during the last twenty years various administrative boards have set values on life and on damages for injuries, but the issues have been complicated and conflicting and have changed materially with recent legislation and constitutional amendments. The adjustments now going on in the region below the ruined St. Francis dam are unique in that they are based on the voluntary action of a great city that immediately assumed responsibility for the disaster. The awards and the principles on which they are based will be awaited with interest the country over, particularly the awards for loss of life and personal injury.

Mixing Time and Strength

WHAT is the proper mixing time for concrete for road pavement? In their specifications thirty-three states say 1 minute, six states say 1¼ minutes, and nine states say 1½ minutes. There seems on the face of things to be no obvious reason for this variation in practice. Within the range allowed by highway specifications there is not enough difference in aggregates the country over to justify it. The water and cement are nearly the same in all states. Two sizes of pavers, a 21-ft. and a 28-ft., are universally used. Reasoning after this manner, the Bureau of Public Roads engineers ask why the 25 to 50 per cent time variation, and particularly why the longer mixing times. Obviously the required mixing period at some point establishes a limit on output of pavement. To answer their own query they are making a series of studies. One of them just completed and described in the bureau journal, *Public Roads*, for July, had for its purpose to determine how much strength is gained from a mixing period longer than, say, half a minute. With a record of some 2,000 test cylinders and numerous other tests the conclusion is that "where standard 21E and 28E pavers in good condition are used, neither strength nor uniformity of test results is improved by mixing the concrete over 45 seconds." Incidentally it is to be noted that this conclusion has support from at least one previous test on concrete mixing for road pavement. The conclusion is significant and deserves very serious attention by concrete road builders. It does not, however, include all the considerations to be taken into account. There is in many instances a material gain in workability by prolonging the mixing time beyond that which shows any advantage measured solely by the strength of the resulting concrete. Again, there is the very practical question of how much of the saved mixing time can be economically used in increasing pavement production. Neither of these questions, it should be observed, is overlooked by the Bureau of Public Roads engineers, and they very particularly sound a warning against extending the mean-

ing of their conclusion beyond its exact wording. This is a caution to be kept very carefully in mind. Compressive strength is not the only criterion for appraising the comparative values of different mixing periods, though it is an obviously important one.

Speed by Competition

COMPETITION between shifts is not an uncommon way of speeding up construction work. Besides increasing the rate of progress it has the added advantage of stimulating the interest of the men in the work in hand as well as developing a spirit of co-operation within each gang in order that the most may be accomplished with the least effort. More frequently such competition is confined to the gangs on one part of the work, but occasionally, as in the case of pouring concrete on a big job, the competition is extended to practically the whole job. Everyone—from the man delivering gravel to the carpenter who builds the forms—must do his bit in order that any one shift may equal or exceed the amount of concrete placed by another shift. Such competition is an asset to the contractor. Within certain limits it is an asset to the owner. So long as good workmanship is not sacrificed in the interest of speed, just so long should it be encouraged.

Flood-Control Plans Advanced

A DEFINITE step toward flood control on the Mississippi River has been made in the report to the President of the findings of the board appointed to pass upon the differences between the two projects considered by Congress. The board has set its stamp of unqualified approval upon the plan adopted by Congress last December, a plan prepared under the direction of the Chief of Engineers, General Jadwin. Regardless of whether one approves of this plan in its entirety—and *Engineering News-Record* does not—if those charged with reviewing the Chief of Engineers' plan in the light of the findings of the Mississippi River Commission are in agreement it is desirable that their findings be announced promptly. Whether the construction of the New Madrid floodway is the best solution of the Cairo problem, whether "fuse plug levees" will fuse at the right time, or whether a wide uncleared floodway is better than a narrow cleared one for the Boeuf River valley are questions that are little advanced toward solution by the findings of this board in its brief survey. The findings will, however, help to speed up work upon those features of the flood-control plans upon which there is mutual agreement, and that is important at the present time.

Imitation in Traffic Control

IMITATION is common in engineering. In no field, however, is as much money expended in merely copying what is being done somewhere else as in that of traffic control. All over the country traffic signals are being bought because of their use (no one knows how efficient) in another city. The town copies the city regardless of radical differences in traffic density. Indeed, cities tend to imitate quite as do the towns and the crossroads.

Los Angeles and San Francisco have warning bells marking the period reserved for pedestrians to clear an intersection. Observing them, another large Western city expresses the belief that its traffic would be materially expedited if only it had bells, yet in the same breath it proclaims that pedestrian control, for which bells are installed primarily, is absolutely impossible. Elsewhere buttons or paint to mark off pedestrian crossings—a current fashion—are adopted merely because some other city has a hundred thousand buttons or has used so many gallons of paint. The situation is notorious.

Lately a no-parking experiment in Chicago has attracted countrywide interest. The results all favor continuing the prohibition of parking for the central business district of the city. Will then a lot of cities of the size of Grand Rapids, Sacramento and Akron be benefited in equal measure by prohibiting parking? Very likely many of them will conclude so, and a storm of no-parking orders will sweep the country.

It is not to be expected that another feature of the Chicago experiment will be so quickly copied or its conclusions so eagerly accepted. The preliminary traffic survey which Chicago undertook and on the findings of which a no-parking plan was recommended will probably not challenge imitation. Yet this is the very part of the Chicago experiment which should be copied first and is certainly under all conditions deserving of imitation. Dr. Miller McClintock, who made the Chicago survey and recommended the no-parking ordinance, is most strenuous in his warning against adopting no-parking rules without thorough study of the existing street layout and pattern. Street widths, block lengths, character and concentration of business and a dozen other city plan factors must be considered. Primarily, however, it is essential to know the volume, distribution and character of traffic, and these can be determined only by careful count and observation.

Whether Grand Rapids, Sacramento and Akron have street layouts similar to those of the Chicago Loop district, and whether they have reached a sufficient degree of traffic congestion to warrant the same drastic remedy, can be determined only through careful study of the facts, as was done in Chicago by a traffic survey. On the basis of such a determination they can plan the traffic regulation required; they need copy no one, and need accept no signal salesman's opinion.

Dams and the Engineer

CONSTRUCTION of dams is one of the most serious responsibilities which the civil engineer encounters. We said in these columns a few weeks ago that dams should be the safest structures it is humanly possible to build, and the principle is worth reiterating. What is the equipment of the engineering profession for this highly responsible service, and what are its shortcomings?

As concerns the body or main structure of a dam, modern knowledge of design can be depended upon to provide a barrier capable beyond question of withstanding the loads and forces which it will have to resist. This is true despite the fact that the mathematical calculations involved are highly complex and that the uncertainties of temperature and other secondary stresses place complete exactness beyond reach; these uncertainties are after all of limited magnitude and can be covered dependably by a moderate factor of safety. The engineer's task does not end here, however. Provision for carrying the stresses through the main structure is only a single one of the requirements vital to a safe dam. And with respect to the other requirements, the situation is much less satisfactory.

If massive dams are rarely in serious trouble within

their structure, the same thing cannot be said of the foundation. Meticulous refinement in structural design is often accompanied by laxity in attention to the foundation problem; and obviously the most competent and conservative design of the dam itself cannot avail if uplift or undermining occurs. In a study of hydro-electric plant failures recently carried out, it was found that undermining of concrete dams was recorded more than twice as often as failures in any other *two* items of plant between the point of stream diversion and the turbine tailrace. This striking result brings out clearly that dam foundations form a vulnerable spot in the engineer's work—*four times* as prolific a source of trouble as any other single item!

During the past two decades or so, while the stress analysis of dams has been progressing rapidly, no significant advance in foundation practice has occurred, except application of the grouting process. Repeated experience testifies to the fact that there is need for more care in the selection of suitable sites, in accurate appraisal of foundation conditions and in thoroughness of field engineering during construction to assure that the foundation shall be made completely safe and dependable. In recent months much emphasis has been placed upon the importance of studies of foundation conditions, and properly so; this is the beginning, we trust, of a movement which will place foundation practice upon the same plane of excellence as the design and construction of dam superstructures. Only when this end has been reached shall we be able to say that the art of building dams is abreast of the possibilities of modern technical science.

Many practical considerations, beyond the range of mathematical analysis, are involved. There is the question of possible seepage through the substrata, and whether the foundation material may change its condition under water pressure. Rock that is amply hard and solid when dry may be wholly unsuitable as support for a dam because of changes it undergoes when subjected to water pressure—as evidenced so disastrously in the case of the St. Francis failure. The soil strata may contain veins of soluble material. And, finally, rock that is sound in every other respect may be subject to occasional tectonic movement jeopardizing the safety of the dam.

Grouting is a powerful resource in foundation construction. It may often be utilized to make a foundation more dependable, while in some cases it may make it feasible to build a concrete dam on a site that otherwise would not be safe. But whether or not this process can prove of value, there are always two troublesome factors in the construction of dam foundations: the nature of the rock and its depth below streambed. Where solid, impervious rock is found at streambed level the problem is simple. This favorable condition is met only rarely, however. More often the problem is to determine how poor a grade of rock is compatible with safety and what depth of foundation below streambed satisfies the requirements of both safety and economic feasibility. Lack of adequate exploration on the one hand and false economy on the other are potential sources of danger to dams. Neither is a valid excuse for unsafe construction, yet they are frequently enough in evidence to support the claim that proper legislation ought to be passed in order to protect the public against their results.

The practice of building concrete dams, in short, has advanced less than the theory. Particularly in the field of foundations optimistic assumptions have been frequent and the full application of engineering science relatively rare. Safe construction calls for clear appreciation of all factors involved in the service and long-time endurance of dams. The engineer who would carry out his full obligations in building dams has need for an unusual breadth of view and ample practical knowledge.

The Question of Veneered Concrete

THE paving-brick covering of the Caneadea dam, described in this issue, strikes a note of novelty in protective facings for concrete. Indeed, it deserves notice from several viewpoints. First, however, distinction has to be made between the facing of concrete with masonry as at Caneadea and the earlier and very common practice of filling in with concrete between single-course masonry face walls. The section of the Boyds Corners dam published last week is an example of the earlier structure type. In such designs the stone facing and concrete backing were considered as taking stress together.

In the Caneadea dam the concrete section alone is regarded as the working structure, and the brick as a mere integument cloaking and guarding the body of concrete. So also in most of the stone-faced concrete bridges which have been recently constructed the concrete alone is the carrying structure and the single course of facing stone is merely a veneer superimposed on the concrete for esthetic reasons and as a protection. In the case of dams there is another good reason for the surface covering. It prevents the visible scaling which sometimes takes place on concrete surfaces and which so commonly causes public suspicion of structural integrity and apprehension of danger.

There were two purposes in facing the Caneadea dam with brick. Primarily it was put on as a precaution against the possible disintegrating effect of frost; secondarily, it was used to make the dam tight against water. Incidentally it had the construction advantage of reducing the cost of formwork. With the brick skin laid up in mortar and perfectly tight, only a skeleton type of form panel was required to hold the concrete. Analagous methods have been employed in other faced-concrete construction operations. A notable instance is the Eguzon dam in France described in *Engineering News-Record*, Sept. 22, 1927, p. 458. Here a stone masonry facing was braced by steel I-beam studding anchored back into the dam.

Obviously, however, it is not as a construction device that brick or stone facing of a concrete dam is to be justified. Its economic warrant must exist solely in its service as a protection. What is its probable service? The concrete will be kept from disintegration by frost, but how much does good concrete need such safeguarding? There will be many who will claim that it does not need it at all and they can point to many proofs in concrete structures which have stood every vicissitude of weather and climate without surface damage. There are other concrete structures whose surfaces have raveled to unsightly appearance under the same conditions.

This being the evidence, is it then the engineer's mission to house in all his exposed concrete in the fear that some of it may scale and spall or is it his mission rather so to perfect his design and control of concrete mixtures and so to devise their placing and curing that all concrete structures are as resistant and enduring as many of them have proved to be? There should be no excuse except an esthetic one for covering concrete with stone or brick or any other material, and even the esthetics of the practice is questionable.

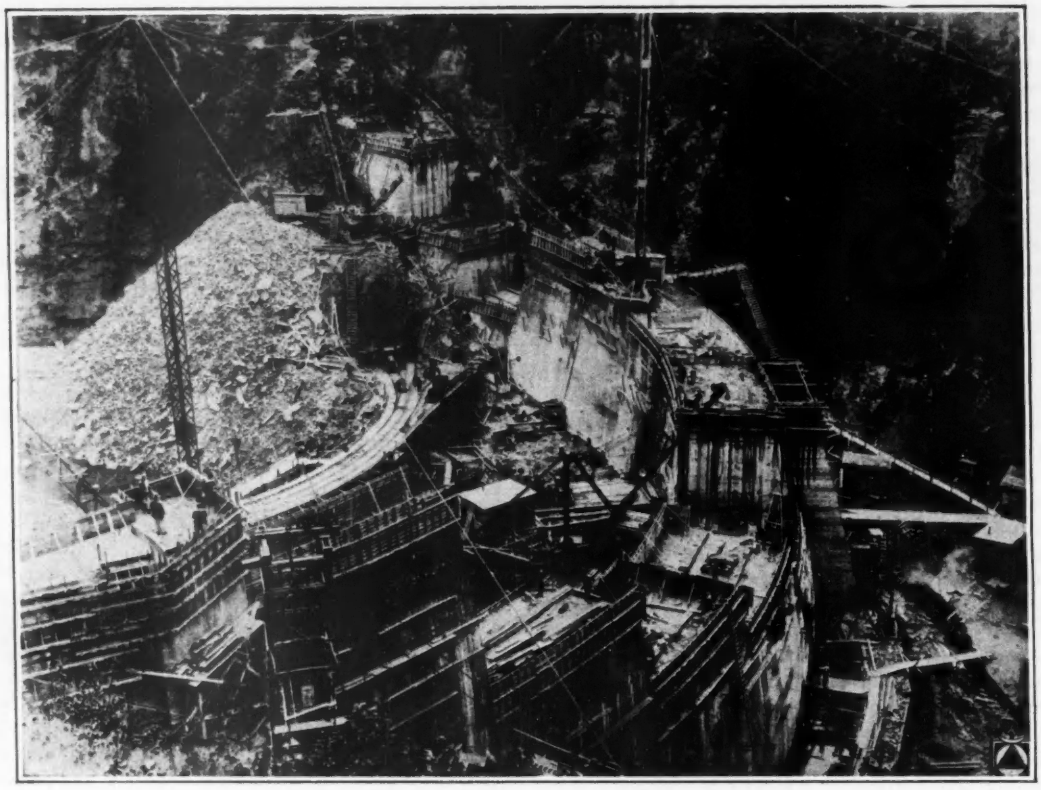


Fig. 1—Construction of the Caneadea Dam, Caneadea, N. Y.

Building a Brick-Faced Concrete-Arch Dam

Brick Armor on Both Faces of Caneadea Dam to Resist Frost Action—Difficult Plant Layout in Deep Gorge—Cold Weather Concrete Well Protected

By Herbert W. Reutershan

Resident Engineer, Gannett, Seelye & Fleming, Engineers, Inc., Harrisburg, Pa.

FACED on both sides with vitrified brick, the concrete-arch Caneadea dam in western New York is unique and one of the few high arch dams east of the Rocky Mountains. The purpose of the brick facing is to resist frost action and to prevent surface disintegration of the concrete. The dam also stands out as one of the few arches having gravity-section concrete abutments. Construction methods were complicated by the specifications, which permitted concrete to be placed with buckets only; chuting or belt conveying was prohibited. Working and storage space was restricted to a deep, narrow gorge, requiring a well-laid-out plant in order to carry on the work without interruption. The construction plant and methods and the utilization of the brick facing as part of the form work are described in this article.

The purpose of the Caneadea dam is to control the flow of the Genessee River and to impound water for the use of the power plants of the Rochester Gas & Electric Corporation in Rochester during the dry months. The dam is located on Caneadea Creek at its junction with the Genesee River and in a narrow gorge about 300 ft. deep. The site is 1½ miles from the village of Caneadea and about 60 miles south of Rochester. The gorge widens out rapidly above the dam, forming a lake 2 miles long and 1½ miles wide, covering 800 acres and impounding 1,200,000,000 cu.ft. of water. The completed dam and reservoir are shown in Fig. 7.

Design—The dam is a constant-angle arch, 140 ft. above the streambed, with a maximum radius of 262 ft.; it was constructed in eleven 40-ft. segments for a total arch length of 440 ft. On the north the arch is flanked by a concrete gravity-section abutment 100 ft. long, and on the south end by a similar abutment 80 ft. long. With a maximum bottom thickness of 44 ft. at the center, the cross-section tapers to a width of 5 ft. near the top and then flares out on the downstream side for a 10-ft. sidewalk along the top. The plan and typical cross-section are shown in Fig. 2.

The foundation across the bottom and at both ends was carried deep enough into solid rock to provide a complete cutoff. The rock was a shale formation in thin compact layers, so that both the upstream and the downstream sides of the excavation had to be line-drilled or

channeled to prevent excessive overbreakage. Along the upstream toe a cutoff channel was excavated across the bottom and well into the sides of the gorge. The vertical face of the rock cut in the sides of the gorge ran as deep as 40 ft. Fig. 5 shows a section of foundation with the cutoff trench ready for concrete.

The spillway at the extreme north end of the dam adjacent to the north abutment is concrete lined and is cut almost entirely in rock. It is 60 ft. wide and 20 ft. deep and is fully controlled at the upper end by two all-steel, electrically operated vertical sluice gates, 20x20 ft., supported by a concrete pier in the center. Further control of the reservoir is effected by two 4½-ft. diameter sluice pipes through the center section of the dam near the bottom and extending 80 ft. downstream. Flow through these sluices is governed by sluice gates on the upstream ends and by Johnson-type valves on the downstream ends. Immediately above the sluice pipes are two 6-ft. penstocks to supply water to a future power house; the upstream ends of these pipes are also controlled by sluice gates. The upper-end control mechanism of both outlets is located in a gate house on the top of the dam.

A notable feature of the design is that the arch is faced with 4-in. vitrified paving brick. Both sides of the arch were faced above the natural ground level, but no facing was put on the abutments or spillway walls. This facing is described more in detail in a succeeding section.

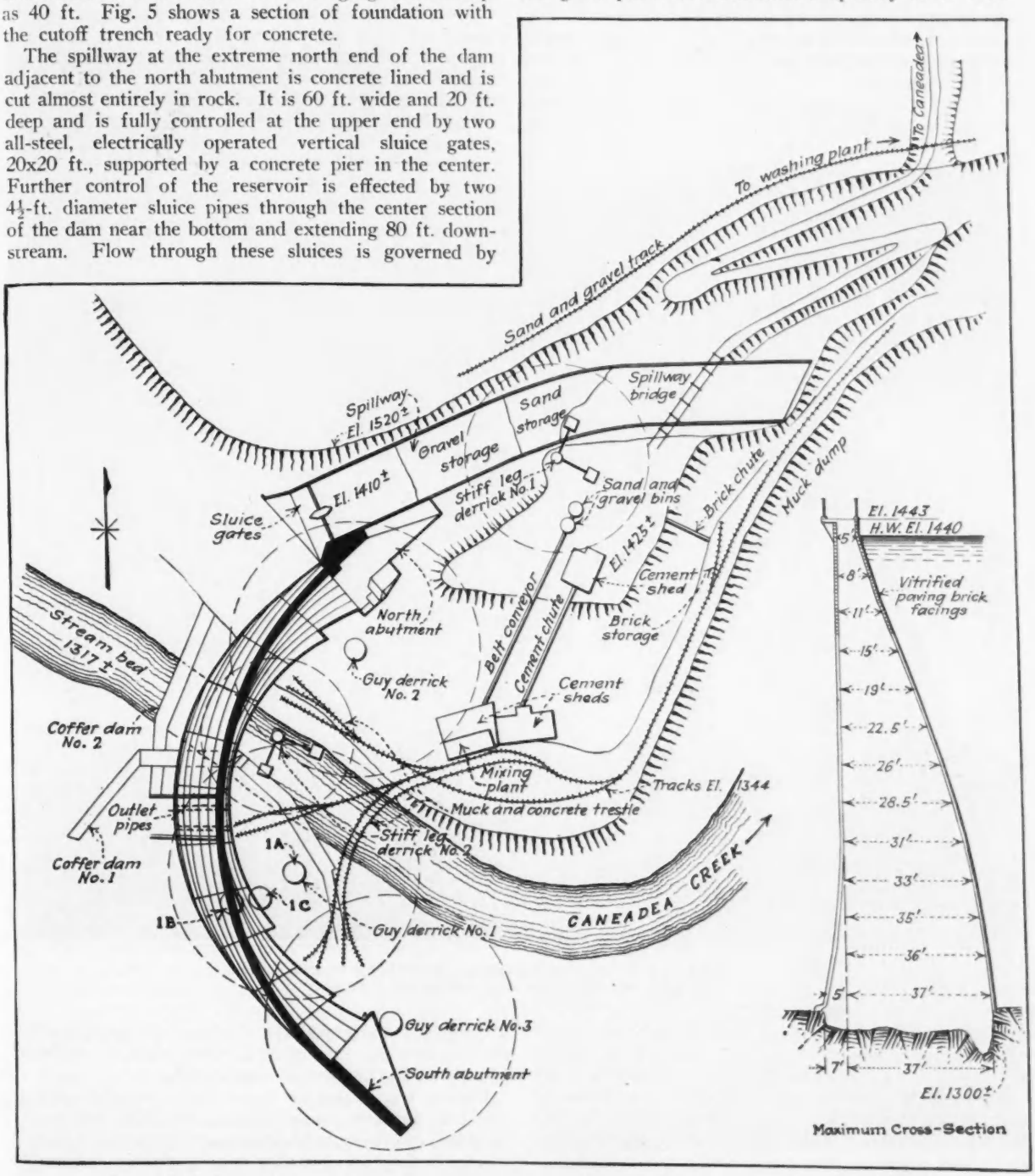


FIG. 2—PLAN AND TYPICAL CROSS-SECTION OF CANEADEA DAM, SHOWING CONSTRUCTION PLANT AND MATERIAL STORAGE LAYOUT

Grouting and Expansion Joints—Grout holes were drilled with 2-in. diamond drills in the bottom of the cutoff trench on 6-ft. centers and approximately 30 ft. deep. Occasional holes were drilled 100 ft. deep to determine if any seams or faults existed. Pipes were placed in the holes as soon as they were drilled and were

carried up through the first few feet of concrete, the grouting being done after the first few lifts of concrete had been placed. The grout holes extended from end to end of the dam, including the abutment and spillway areas, and at the ends of the structure these holes were fanned out so that not only the strata underneath the dam itself were grouted but also the sides of the gorge back of the abutments.

At the vertical joints between the 40-ft. sections provision was made for expansion and contraction. Near the upstream face, extending from bottom to top, was placed a 6x6-in. asphalt water stop with a 2-in. pipe in the center. After completion of the dam steam was turned into the pipe to cause the asphalt to fuse and form a continuous column, more asphalt being added as the column settled. On the downstream face of the dam there was placed a sheet-metal water stop continuous from bottom to top and designed to allow expansion. Between the upstream and downstream stops throughout the face of the joint there was placed a system of 2-in. grout pipes connected at intersections by split tees. The joints will be filled at a time when maximum contraction in the structure is taking place. Fig. 6 shows the grout pipe system in the construction joint.

Plant Layout and Material Storage—The topography of the site afforded limited working space for plant installation and material storage, so a careful method of procedure was necessary. The plant layout is shown in Fig. 2. Early construction of the spillway enabled that area to be used for sand and gravel storage, as all material was delivered to the north side of the gorge.

Sand and gravel were delivered to the site in 4-cu.yd. cars from a pit and washing plant near by. From the top of the gorge the material was chuted to separate storage piles in the spillway. A steel stiffleg derrick operating a clamshell loaded the material from the stock piles to two steel hoppers over a belt conveyor. The belt carried sand and gravel alternately to storage bins over the mixing plant, situated on a bench below the spillway and about 40 ft. above the streambed.

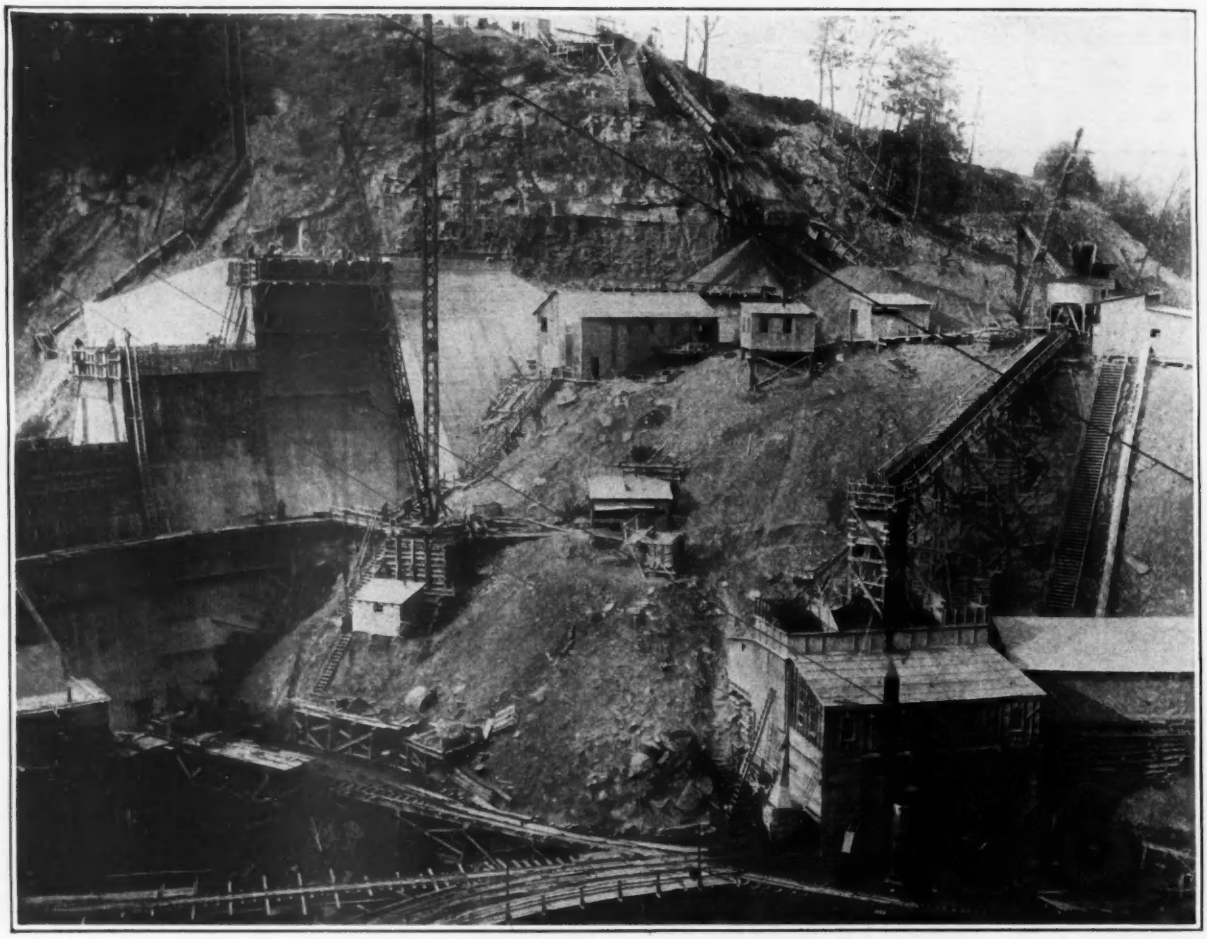


FIG. 3—CONCRETE AND MATERIAL HANDLING PLANT
Deep gorge restricted plant space and material storage.

Cement was hauled by trucks from Caneadea over a road built down the side of the gorge to the spillway level. A system of gravity and roller conveyors then carried the cement direct to the mixers, passing through a storage shed located at the same level as the mixing plant.

The bricks were likewise hauled from Caneadea by truck to the spillway level, chuted to storage piles at the mixer level and from there transferred in skips to the dam as needed.

The mixing plant consisted of two 28 S (1-cu.yd.) mixers charged by the inundation system from two 150-ton overhead storage bins. Care was taken to insure a uniform mix, the specifications calling for a minimum of 1.2 bbl. of cement per cubic yard, and the amount of

water used was such that a man walking in freshly dumped concrete would not sink less than 3 in. or more than 9 in. A uniform and very high-strength concrete was secured. Daily tests were made for slump, and cylinders made daily on the job were tested in the laboratory in Rochester. The concrete was transported in bottom-dump buckets on flat cars from the mixer to three guy derricks and one stiffleg derrick located as shown by Figs. 2 and 3. Gas dinkeys were used to pull the concrete trains. The derricks and track had been used previously in removing the excavated material from the foundations.

FIG. 4—EXCAVATING SOUTH ABUTMENT—CONCRETING FIRST SECTION
Two 54-in. sluice pipes in place—Trestle for concrete and muck trains at left.

Compressed air for the rock drills and grout machines was furnished by an electric-driven compressor on the top of the gorge. With the exception of the gasoline locomotives, the entire plant was electrically operated.

Excavation and Stream Control—Approximately 47,000 cu.yd. of rock was excavated, 21,000 cu.yd. in the dam foundation and 26,000 cu.yd. in the spillway. Owing to the character of the rock light drilling and blasting were necessary to prevent a heavy overbreakage. Fig. 4 shows the excavation of the south abutment.

The rock was loaded by hand into steel skips, hoisted by the derricks, hauled away in 4-cu.yd. dump cars by gasoline dinkeys and deposited downstream and adjacent to the site. Rock excavation for the dam foundation was begun April 29, 1927, and continued uninterruptedly and simultaneously with concrete placing until completion in October.

Handling the stream flow was fairly simple. Without disturbing the stream, a cofferdam (No. 1 in Fig. 2) was built to protect the south part of the structure, including the segment containing the sluice pipes. When this half of the dam was well out of danger of high water, another cofferdam 12 ft. high (No. 2 in Fig. 2) across the channel diverted the stream through the two outlet pipes. Two floods occurred during the early part of the construction before the dam was high enough to be out of danger, but only one of these was heavy enough to go over the top of the 12-ft. cofferdam. A delay of one day in pumping out the coffer was the only damage. A third flood occurred after the lowest section of the dam was up above 70 ft., the water rising about 50 ft. in the forebay over night. The rush of water through the four sluices and penstocks was sufficient to carry away a part of the construction trestle on the downstream side.

Concreting and Brick Facing—Concreting was begun in June, 1927, and was carried on continuously until Feb. 4, 1928, at which time the concrete in the dam, amounting to 66,000 cu.yd., was completed. The 40-ft. segments were poured in 5-ft. lifts, longitudinal raised keys forming the bond to each succeeding lift. The concrete in buckets was lifted into the forms by derricks. One large guy derrick was moved twice from its original set-up to facilitate the concrete placing.

The bricks were laid in mortar, alternating headers and stretchers in each course, previous to placing the concrete. After the forms were removed, all joints were pointed and left flush with the face of the brick.

The advantage of using the brick facing as watertight forms was apparent from the start. While the newly laid brick facing was not strong enough to withstand the lateral pressure of fresh concrete, forms were necessary only to hold the brick in place. They were made up in panels 10x5 ft. of 1x6-in. sheeting widely spaced on 2x6-in. studding. This made a light panel easily handled and set. Fig. 1 shows sections of the forms in place ready for the brickwork.

The routine method of procedure varied little from day to day. Either the next or the second morning after a section had been concreted, depending on the weather and temperature, the form panels were raised and reset. The brick was then laid up inside the forms and allowed to set a minimum of 24 hours before placing the next lift of concrete. In the meantime the joint material had been placed and the horizontal surface of the concrete previously placed was thoroughly cleaned by wire brooms. As construction neared the top, the daily yardage was necessarily small on account of the thin sections, and although on Dec. 1 only 5,000 cu.yd. of concrete remained to be placed, this was not completed until Feb. 4.

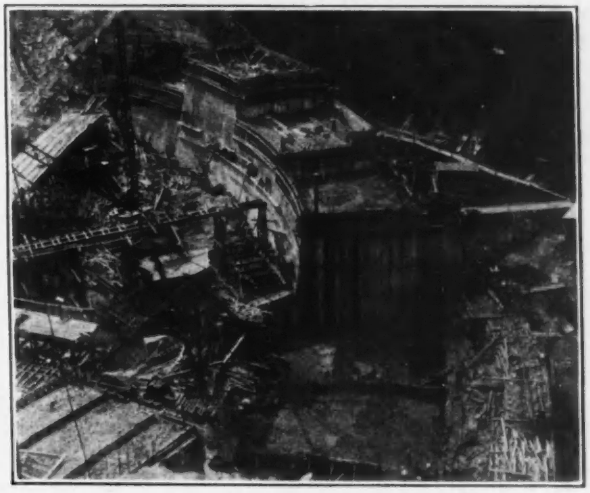


FIG. 5—LAST FOUNDATION SECTION READY FOR CONCRETE
Note 6-ft. penstocks in place for future power house. Creek diverted through sluice pipes.

Cold Weather Precautions—Previous to the arrival of cold weather, the materials necessary to complete the work had been stored on the job and a 300-hp. boiler plant of four units installed to furnish hot water and steam for mixing and protecting the concrete. The

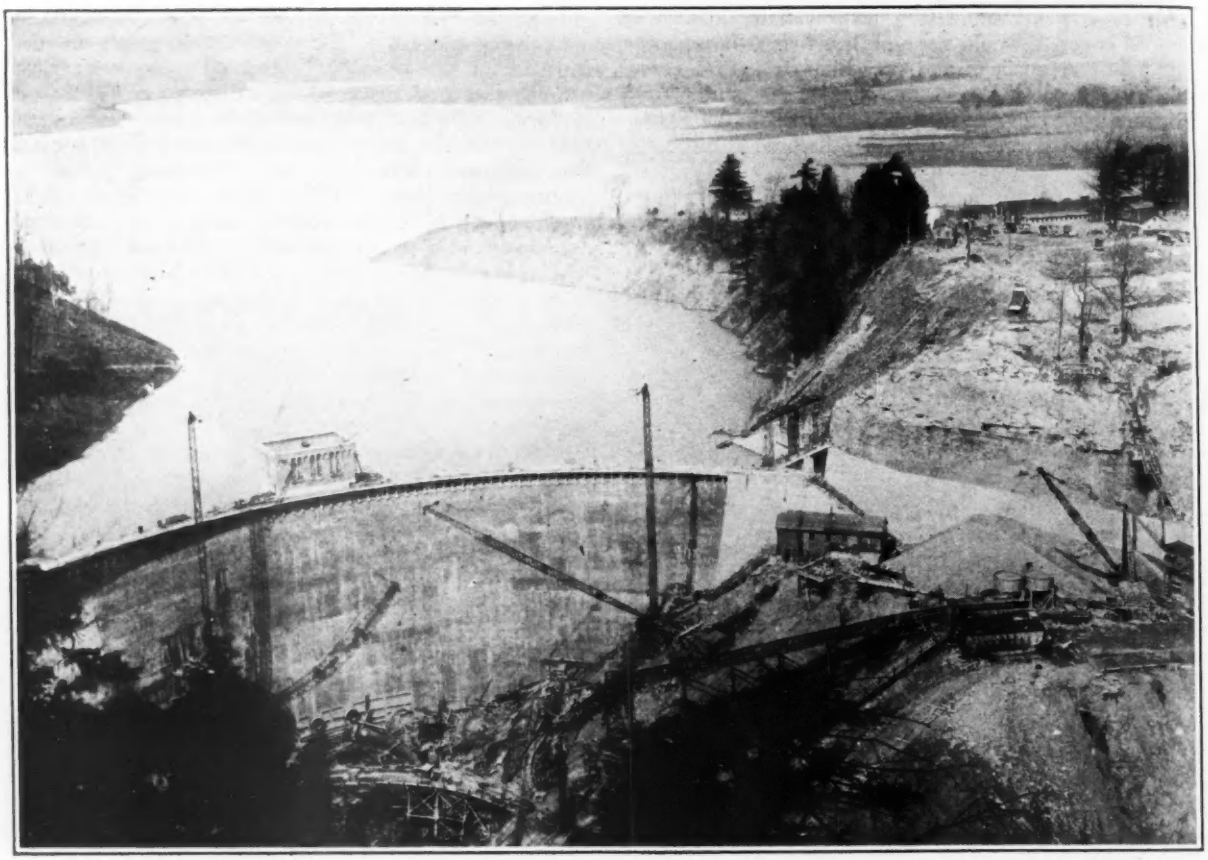


FIG. 7—VIEW OF COMPLETED DAM AND RESERVOIR

boiler plant was located directly in front of the mixing plant on the same level, and the mixing plant housing was extended so that the heat from the boiler warmed the interior of the mixing plant. Steam was piped along the belt conveyor to the material piles on the spillway level, so that the material arrived in the bins over the mixer without frost. Here it was heated by live steam, which entered the bottom of the bins through pipes. Hot water was used in mixing, so that the concrete left the mixers with a temperature of 90 to 120 deg., depending on the outside temperature, and as the time of transportation was short the concrete when placed had lost but little of the original heat. Upon the completion of a section, steam coils were promptly placed along the sides and outside the forms and over the top surface of the concrete and the whole was covered with tarpaulins, so that even with temperatures ranging between freezing and zero the setting was not impeded. A camp to house 400 men was built on the job with a centrally located dining hall, group bunk houses and individual dormitories. All modern conveniences were installed, including a complete water system. A recreation hall was provided with radio and first run moving pictures.

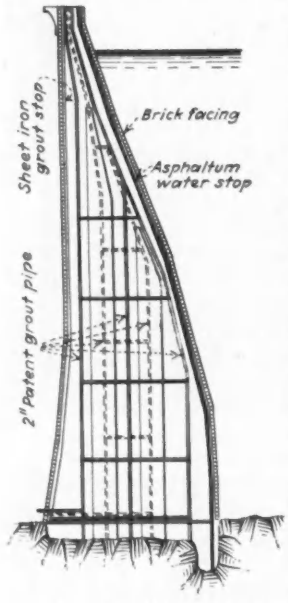


FIG. 6—SECTION OF CONSTRUCTION JOINT, SHOWING ARRANGEMENT OF WATER STOPS AND GROUT PIPES

Personnel—The dam was built by the Caneadea Power Company, a subsidiary of the Rochester Gas & Electric Corporation. The design originated with and is patented by Lars Jorgensen. The plans were prepared by the engineering department of the Rochester Gas & Electric Corporation, and the construction was carried out under the direction of its chief engineer, E. R. Crofts, with Arthur Whitbeck as resident engineer on the job. The plans were checked and approved by the State of New York Conservation Commission, assisted by Hugh L. Cooper, of New York. The contractor was Gannett, Seelye & Fleming, Engineers, Inc., of Harrisburg, Pa., with E. M. Kayser as superintendent, Walter K. Ward assistant superintendent and the writer resident engineer.

Philippine Survey Practically Completed

The task of surveying the Philippine Archipelago, began by the United States government in 1901, is now approaching completion. This work included the joining of 280,377 sq.mi. of water and the complete survey of 7,080 islands, of which only 466 have an area of more than 1 sq.mi. In mapping the islands, an accurate determination of 20,260 miles of shore line was necessary. The task was done by the Coast and Geodetic Survey.

Studies for Additional Water Supply for Milwaukee, Wis.

Annexation Program Fostered by City, Together With Natural Growth, Has Led to Study of Needs and How Best Met

By C. S. Gruetzmacher
Research Engineer, Water Department, Milwaukee, Wis.

ANNEXATION in accordance with a well-organized plan, combined with a steady increase in building activity both in the central business section of the city and in the outlying annexed districts, has led the common council of Milwaukee to authorize a comprehensive study for an additional water supply and its distribution. The work is now in progress. It includes growth in area and population, variations in the future demand for water, by districts, the best location for a new intake, the possible future need for a filtration plan, and the layout of feeder mains and water consumption districts on a 1950 basis. The efficiency of the present feeder mains is being determined by a pitometer survey.

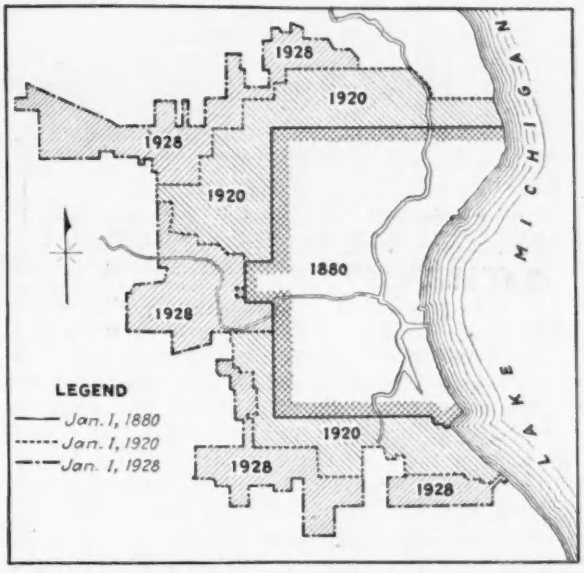
Milwaukee is one of the most densely populated cities in the United States. Since 1920 it has annexed 11 square miles of adjacent suburban territory. It now has an area of 36 square miles and a population of 535,000. The survey now in progress indicates that by 1950 the population will be 980,000.

In 1880 the population of Milwaukee was 115,587 on an area of 15 square miles, a density of 7,700 per square mile. Forty years later the area was 26 square miles and the population 457,315, a density of 17,600 per square mile, with certain sections having a density of 45,000 per square mile. The city was very compact in comparison with other cities of the same population, and public works within the area were being utilized to a maximum efficiency. The assessed valuation of the city in 1880 was $94,763,090 (based on a 100 per cent valuation). This grew to $675,611,640 in 1920 and at the beginning of 1928 had reached an estimated figure of $925,000,000.

Since 1920 the movement of the resident population to the suburban areas, consequent upon the introduction of cheap transportation—the automobile, rapid transit and bus lines—and the desire for less congested living conditions, caused a rapid development of the adjacent suburban districts. These districts, in the main, were wholly without the conveniences which the people had enjoyed while in the city, such as fire and police protection, sewer and water facilities, paved roads and lighted streets. There was a time shortly after the year 1920 when the city itself, realizing that it must expand its area or cramp its future existence, endeavored to annex certain strips of territory to alleviate this condition, but this met strong opposition from the local governments. Now most of such opposition has been successfully overcome and it is the rule rather that more territory is requesting annexation to the city than the latter can immediately accommodate.

Water consumption has increased as a result of annexation from 66.9 m.g.d. in 1920 to 76.5 m.g.d. in 1927; maximum daily consumption from 89 to 106.5; from a rate of 120 in 1920 to 161 m.g.d. in 1927, with a high peak rate of 190 m.g.d. in the latter year.

In connection with the location for a new intake and crib in Lake Michigan, samples of the lake water are being taken daily by means of a boat at various locations north and south of the harbor entrance and at distances from ½ mile to 3 miles off shore. At the mouth of the harbor the discharge of three rivers is concentrated, and with the new sewage-disposal plant located there, the maximum pollution of the lake water is found at this point. It has been a generally accepted theory that the lake water north of the harbor entrance is generally pure on account of a supposed lake current flowing in a southerly direction along the west shore of Lake Michigan. Thus far this theory has been found to be erroneous and the samples of water taken south of the harbor entrance have been found to be as good in quality as those taken north thereof. The influence of the new sewage-disposal plant in treating most of the sewage of the city and which formerly flowed into the lake at the harbor entrance has been the governing factor in producing this condition of the lake water. These water samples are examined chemically and bacteriologically



SKETCH MAP SHOWING ENLARGEMENT OF MILWAUKEE BY ANNEXATION

and the results of the tests are being analyzed in connection with meterological data from the local weather bureau.

It is expected that this survey will be practically completed by the end of this year and that a comprehensive report will be available upon which to base a future construction program. The investigation by the water department is under the direction of the city engineer, J. P. Schwada, and is being conducted by the writer as engineer in charge.

Grand Rapids Water-Works Program Postponed

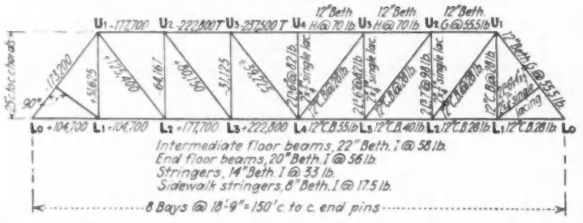
Due to a political situation, the usual water-works bond issue for general extension of mains and certain major improvements at Grand Rapids, Mich., was defeated at both the March and April elections. One of the items provided for a complete carbonating installation at the filtration plant. There was also under consideration an extensive program involving more than $1,000,000, and covering three or four years' construction time, but this whole matter will have to be deferred for about a year.

Rolled Structural Sections Used in Rio Grande Highway Bridge

By Phillips B. Tartt
Consulting Engineer, San Antonio, Tex.

THE MAIN channel crossing of the new Rio Grande toll bridge to be built between Del Rio, Tex., and Villa Acuña, Coah., Mexico, will consist of four 150-ft. Pratt truss spans. In order to decrease the cost of shop work and to secure an economical and satisfactorily rigid and durable bridge the writer has designed therefor standard trusses which have certain unusual features. There is nothing new in the type of trusses and bracing, and the only departure from the orthodox Pratt truss diagram is the addition of the end post bracing struts which run from L_1 to the end post and make a right angle therewith.

The departure from customary practice is in the design of the sections of the truss members themselves


Intermediate floor beams, 22" Beth. I @ 58 lb.
End floor beams, 20" Beth. I @ 56 lb.
Stringers, 14" Beth. I @ 53 lb.
Sidewalk stringers, 8" Beth. I @ 17.5 lb.
6 Bays @ 18'-9" = 150' c. to c. end pins

PRATT TRUSS BRIDGE OVER RIO GRANDE BUILT OF ROLLED STEEL SHAPES

and the use of rolled sections throughout in place of the usual built-up sections. In going over the new Carnegie and Bethlehem rolled sections it was apparent that there is a very wide selection of radii of gyration and cross-sectional areas available in rolled sections of exactly the same depth. All the main members of the bridge, with the exception of the interior verticals, are rolled H-sections with the web horizontal in every case. Although necessary to make a slight sacrifice in unit compressive stresses on account of slenderness, it was found to be a comparatively simple matter to keep the ratio of l/r well under 120 in all members except the end posts and interior verticals. The use of the end post braces to reduce the value of l/r to less than 120 has already been noted and a compromise was made on the interior verticals by using two latticed channels.

It is felt that the slight excess metal due to the lower unit compressive stresses in the rolled sections is more than compensated for in the saving in the inert material of the lacing that would have been required in built-up sections. The amount of shop work and the number of rivets eliminated is enormous. To eliminate any possibility for the horizontal chord surfaces to collect water all horizontal members will have ½-in. holes drilled at 4-ft. intervals throughout their length. If complete drainage should not result, it will be a simple manner to fill these channels with a soft asphalt filler.

The bridge, which is for light international traffic, is designed for a roadway live load of 60 lb. per sq.ft. in the trusses and two 12-ton trucks in the floor system and hip verticals. An impact allowance of 25 per cent has been added to all live loads. The unit stresses in steel used are those recently recommended for buildings by the American Institute of Steel Construction, which the writer considers nearer the rational ideal for this type of construction than anything hitherto published. The reinforced-concrete floor is designed for 700 lb. per sq.in. compression in concrete and 18,000 lb. per sq.in. tension in reinforcing steel. To reduce the dead load the floor of the walkway is designed of checkered steel plates.

Conclusions in Prize Paper on Arc Welding

IN THE competition for the best three papers disclosing advancement in the art of electric arc welding originated and financed by the Lincoln Electric Company, Cleveland, Ohio, and sponsored and directed by the American Society of Mechanical Engineers, James W. Owen, director of welding for the Newport News Shipbuilding & Dry Dock Company, received the first prize of $10,000. The title of Mr. Owen's paper was "Arc Welding—Its Fundamentals and Economics." These conclusions are taken from Mr. Owen's paper:

1. Arc welding can be applied to a wide range of work from the small and light airplane joints to strength joints in the largest and most complex structure made of steel—a ship's hull.

2. Arc welding has reached a state of scientific and practical development which insures that reliable results can be consistently obtained.

3. Arc welding possesses many practical advantages over riveting, the most important of which are higher joint efficiencies, tightness and savings in weight.

4. Arc welding possesses greater possibilities for reducing costs and increasing profits by its use in new construction and salvage than any other known process.

5. When arc welding has more fully demonstrated its reliability, the ship classification societies will undoubtedly permit further reductions in the scantlings of ships.

6. Automatic welding makes possible very much greater speeds and a superior product.

7. The principal savings by welding are made in the drawing room; therefore design problems should not be left to shop men.

8. The future of gas cutting is intimately bound up with the extensive utilization of arc welding in new construction and repair.

9. The gas, resistance, thermit and forge welding processes have certain advantages, and a working knowledge of all of these should be obtained by the engineer supervising the development of welding.

10. Welding development should be in the hands of competent engineers.

11. The advance of welding has been handicapped by a lack of satisfactory design values for welds and simple methods of showing welds on drawings.

12. It is recommended that the steel mills consider the rolling of larger tees and other sections required for economical welded construction.

13. Arc welding is fully capable of standing on its own merits. Therefore, if the cost of the product cannot be reduced or the product improved by its use, then, except in special cases, processes or methods which will give the desired results should be used.

14. Our knowledge of arc welding is far from complete, but that which is available is ample for a sound progressive development if guided by the engineering profession, and it is recommended that our technical schools establish courses to supply the demand for capable engineers, in this new, interesting and profitable profession.

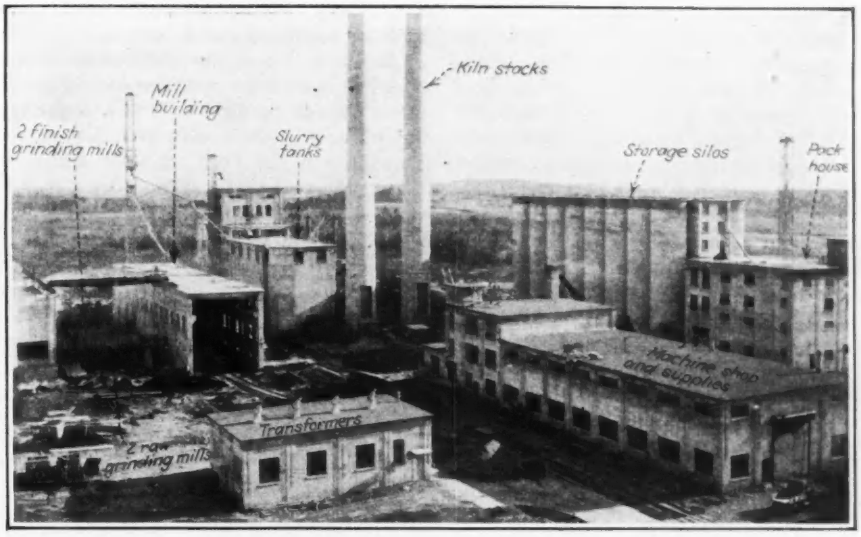


Fig. 1—Some of the Concrete Buildings in New England's First Portland Cement Plant

Locating and Building a Large Modern Wet-Process Cement Plant

The New 1,000,000-Bbl. Plant of the Lawrence Portland Cement Company Provides a Study in Modern Plant Location—Arrangement of Necessary Units—Construction

By C. H. Sonntag

Consulting Engineer, Lawrence Portland Cement Company, New York City

SINCE the new wet-process plant of the Lawrence Portland Cement Company is the first portland cement plant in New England, the determination of its location afforded an excellent opportunity to apply many of the theories of industrial plant location. The plant was designed to be modern in every respect and to have an annual capacity of 1,000,000 bbl., with provisions for doubling this capacity whenever necessary.

Construction work, begun on an uncleared and undrained site near Thomaston, Me., in May, 1927, was completed in April, 1928, and the first trainload of cement was shipped May 14, 1928. Into the numerous buildings and other structures which make up the complete project went 55,000 bbl. of cement, 40,000 tons of crushed stone and gravel, 25,000 tons of sand, 3,000 tons of reinforcing steel, 1,000 tons of structural steel and 1½ million ft.b.m. of form lumber. Necessary excavation and grading totaled 60,000 cu.yd.

In carrying out a project of such magnitude with speed and dispatch, many problems of construction technique and job co-ordination arise. Some of the more important of these, such as the use of sliding forms, winter construction and the erection of two 235-ft. concrete stacks, are briefly described below. But, from one point of view, the most important phases of the project lie in the economics of its location and the general outline of its design. These will be treated in considerable detail.

Factors Determining the Choice of Plant Site—The location of a plant for the manufacture of portland cement is determined by special considerations, many of which are not common to the location of the average industrial enterprise. The primary raw material needs in making portland cement are some form of lime and some source of clay or its equivalent. Secondary, but almost equally important, are cheap fuel and plenty of power at a reasonable price. Nearly every state contains the raw materials for cement making. Perhaps careful prospecting would show that all of them do. But it does not follow that a mill can be built and operated as an economic enterprise at every deposit, nor even in every state. Such factors as transportation, cost of fuel and proximity of market must be considered.

Considering the great technical skill required to make cement and the extremely heavy investment in its factories, it is a very cheap commodity per pound—cheaper than any other requiring equal knowledge and capital. But it is easily damaged by water, and so must be shipped in rainproof cars, which are usually tagged as being fit for grain loading. Hence freight rates per 100 lb. on cement are considerably higher than those on sand and gravel and other low-grade materials. This would dictate that a cement plant should be located near a large consuming center.

On the other hand, nearly half the weight of pure limestone is the invisible gas, carbon dioxide, which is driven off during calcination. In fact, if the stone were chemically pure calcium carbonate, 44 per cent of its weight would be lost in this way. The loss on the better class of commercial limestone is usually more than 40 per cent. When limestone is shipped, this 40 per cent is still a part

of its weight and freight must be paid on it. Based on these facts, a cement mill using limestone should be located at the quarry, and the stone should be taken directly into the plant without paying freight to any outside agency. This reasoning applies also to the shale or clay, although in a less degree, since only 20 per cent or less of the raw material is clay, and its loss on calcining, which is mostly water, is only 10 or 12 per cent.

Boston is the only large center of population in New England. Its distance from any limestone deposit is such as to make shipment of stone to a plant located near Boston too expensive. Boston is not near the center of the balance of population of New England, but at one edge of it, and cement made near Boston and not used there would have to take a backhaul to other cities, against the flow of limestone to the mill. It follows that a New England cement mill should be located at the limestone deposit, especially when suitable clay is on the property.

Why Located at Thomaston?—The limestone deposit in the Thomaston-Rockland region is thoroughly well

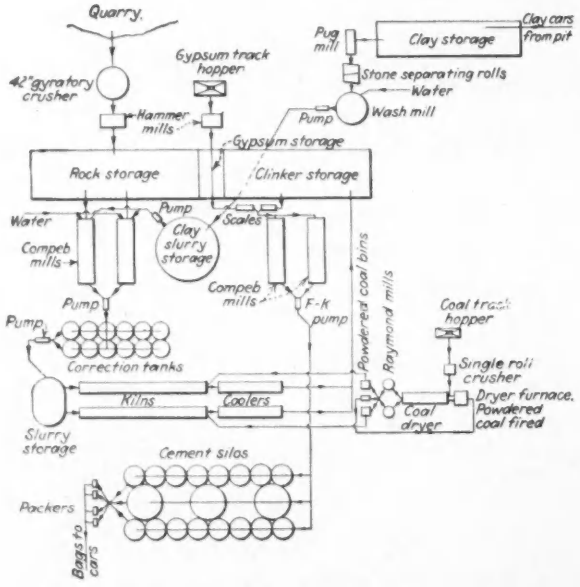


FIG. 2—LAYOUT PLAN OF NEW PORTLAND CEMENT PLANT AT THOMASTON, ME.

known, having served as the source of raw material for an extensive limeburning industry for the past hundred years. The high quality of the stone has been determined not only by large quarrying operations but by careful core drilling to a depth of several hundred feet on the property that will supply the cement mill. Clay of ideal composition is found on top of the stone, being left there by glacial action, and also as a marine clay filling the stream valleys. These latter deposits of clay are at least 150 ft. deep, having been placed when the ocean was nearly 200 ft. higher than it is now. The surface of the stone is nearly level, heavily scored with glacial grooves and without the clay-filled seams that make many quarrying operations aggravating and expensive. Both stone and clay are available in quantities far beyond any likely use.

The harbor of Rockland is one of the best on the Atlantic coast and affords excellent facilities for water shipment. Nova Scotia gypsum can be received by water, and West Virginia slack coal will be brought in by vessel from Middle Atlantic ports. Both Thomaston and Rockland are on the lines of the Maine Central Railroad.

Choice of Particular Site—The property now comprised in the Maine holdings of the company consists of nearly 900 acres, most of which is the quarry, clay land and mill site, but it also includes an extensive harbor frontage and the right to build and operate a railroad joining the two. The largest tract, including the quarry

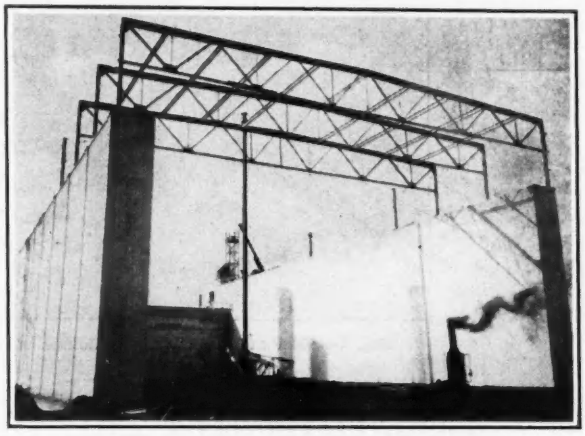


FIG. 3—HEAVY WALLS OF CLINKER STORAGE BUILDING
Steel trusses being erected by gin pole.

and clay land, is about 3 miles from the shore property, and the mill could have been built in either location. A careful analysis of the situation was made, including the cost of transfer of raw materials, fuel and cement between the two sites; and a forecast of probable water shipments for the next few years was also made. As a result it was decided to build the mill at the quarry, having the Maine Central Railroad switch coal and gypsum from its docks to the mill, and cement from mill to dock, the cement company providing and operating the mechanical equipment on the dock.

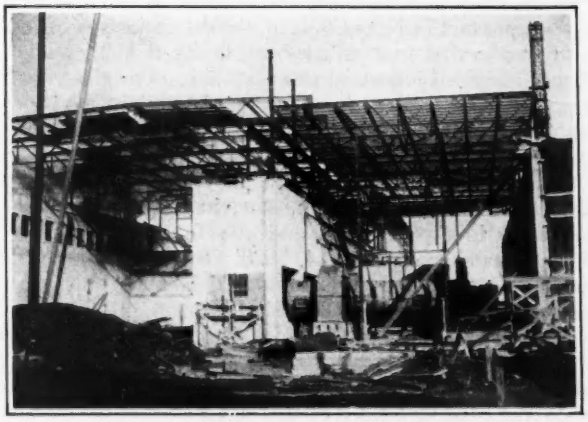


FIG. 4—GRINDING ROOM WITH STORAGE BUILDING TO LEFT AND MILL BUILDING TO RIGHT

General Design of Plant—The wet process of cement manufacture was selected for the new plant, since it would have been both difficult and expensive to dry the clay as necessary in the dry process. In the wet process the rock is crushed down to about 1-in. size while containing its natural moisture, and the clay is mixed with water to a thick pulp of such consistency that it can be handled by a centrifugal pump. The rock and clay pulp are fed into the grinding mills with enough additional

water to give a product containing about 35 per cent water. The mixture of finely ground solids and water is a rather thick mud known as slurry. In this condition it is fed into the kilns, where both drying and calcining are carried out as one operation.

The design of this type of cement mill depends on the use of two machines: (1) The large overhead electric traveling crane equipped with a grab bucket which operates over the covered storage bin of stone, gypsum and clinker, transferring these materials to the hoppers feeding the grinding mills; and (2) a special type of pump, a device for transporting dry powders through a pipe line which may be as much as 1,000 ft. long and which may have many turns and may rise 100 ft. above the pump.

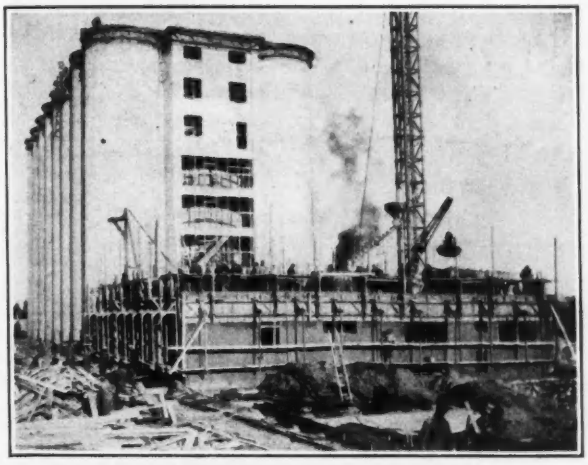


FIG. 5—ERECTING THE PACKING BUILDING WITH SLIP FORMS
Storage silos completed.

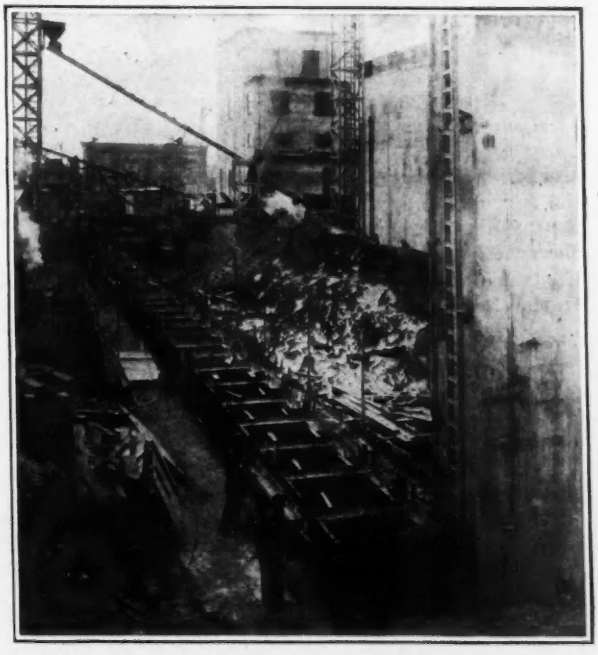


FIG. 6—PLACING FORMS FOR CELLULAR STORAGE WALLS

The use of the overhead crane usually requires that raw materials enter one side of the storage and that the grinding mills be ranged along the other side. Clinker may enter at either side.

Use of a pulverized material pump permits the storage silos, and in some instances the coal-grinding mill also, to be located without much reference to the rest of the plant. The old system of screw conveyors and bucket elevators required a close connection between the two.

Having decided to locate the plant at the rock deposit, it was logical to place the crushing plant so that cars loaded by the electric shovel could be hoisted directly to the primary crusher and dumped into it. Fig. 2 shows the general layout of the mill and its relation to the quarry. The flow of material through the plant may also be traced out on Fig. 2.

Rock is hoisted from the quarry, crushed to 1-in. size and carried by two 30-in. belt conveyors into part of the main storage. Clay is dumped into storage, whence it goes through the granulator, rolls and wash mill to the clay-storage basin in the mill building. Crushed rock goes from storage to the two raw grinding mills, where water and the proper amount of clay are added.

The slurry from these mills is pumped to any one of twelve slurry tanks, and from these it is uniformly fed into the kilns. Coal is received in a track hopper, crushed if necessary, dried, ground and blown into the kilns, furnishing the heat for calcining the raw material to clinker. The clinker passes through rotary coolers and is taken by drag chain and elevator to a section of the main storage. Gypsum is received in a track hopper, crushed and elevated to storage. Clinker and gypsum pass through automatic proportioning scales to the finish grinding mills. The resulting cement is pumped to any one of the storage silos, from which it is later withdrawn and packed in bags for loading into cars.

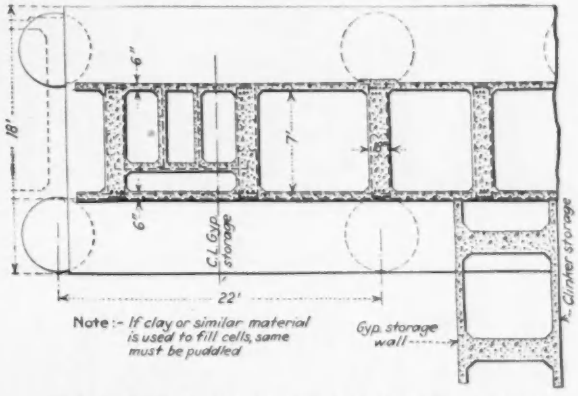


FIG. 7—DETAILS OF STORAGE BUILDING WALLS
Clay filling was placed in pockets to provide necessary stability.

Some Design Details—The surface of the site selected for the plant was nearly level, with the soil above the rock varying in depth from 12 to 30 ft. This soil consisted of brown and blue clay, with some sand and boulders. Because of a question as to its bearing power under the vibration always existing in a cement mill, the principal buildings rest on a series of round concrete piers carried to solid rock; the piers for the heavy machinery are also carried to rock. Slip forms were used not only for the circular structures but also for all of the principal buildings.

Cellular Walls—Of particular interest are the side walls of the main and clay storages. These are essentially retaining walls, but must carry in addition the heavy moving loads of the overhead cranes. If built along conventional lines, they would require cumbersome and expensive stationary forms, since they are 55 ft. high.

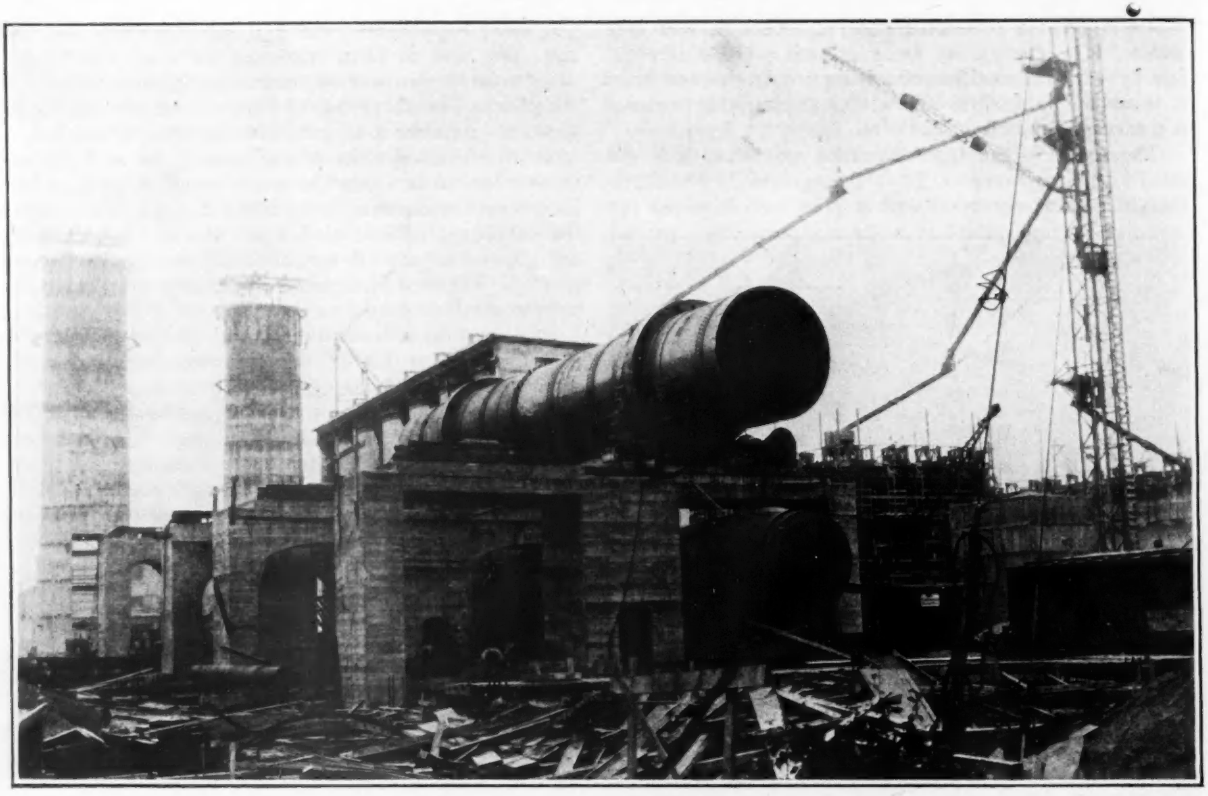


FIG. 8—ERECTING THE KILNS AND CLINKER COOLERS
The kiln is 11 ft. diameter by 200 ft. long and the clinker cooler (beneath) 10 ft. in diameter by 90 ft. long. In the background the two 235-ft. stacks are being constructed by the use of special tapered forms.

To avoid this, the engineers of the contractors designed a special cellular wall (Fig. 7). It consists of two rather thin longitudinal walls joined by transverse partitions, and since it is of uniform section from top to bottom, it was built with sliding forms. The weight of the concrete alone is not sufficient for stability, and this was obtained by filling the cells with clay, earth or other cheap material of the required density. The wall rests on a concrete slab and the footing is designed like that of any other retaining wall. Lack of confidence in the bearing power of the soil under heavy loading led to the carrying of each of these retaining walls on a reinforced-concrete slab, resting on a series of spirally reinforced circular columns carried to rock.

Construction—Although the land selected for the mill site has a slight general slope away from the quarry and so afforded a limited natural drainage, the laying of railroad tracks and the excavation for foundations interfered with this. Since the design of the plant called for two permanent concrete tunnels, to be used both for drainage and to carry the electric power cables and pipes for steam, water, air, cement and slurry, these were built immediately after clearing the land in order to provide construction drainage.

The rainy weather and the nature of the soil made it unwise to keep foundation excavations open for any length of time and they were promptly filled, even if other work had to be stopped. Concreting was, of course, one of the major jobs. It was accomplished largely by means of tower and chuting plants and the considerable distance that some of the concrete had to be moved made it necessary to chute concrete from the top of one tower to the foot of another, and then to re-elevate it for further chuting.

Much of the concrete work, both slip form and massive, was done during the winter. Fortunately the season was exceptionally mild for Maine climate, although the average temperature was well below freezing. For the massive concrete the sand and stone were heated over sheet steel tunnels, while the water was heated by steam. Concrete from such ingredients was steaming when it reached the form, and the use of a few salamanders supplemented by a covering of pine and spruce branches was found to be effective to prevent freezing.

Most of the slip form construction surrounded the inclosed spaces, so that the interior could be adequately heated by salamanders. On the outside, the forms were surrounded by staging about 5 ft. wide and 12 ft. deep, carrying a framework covered with tarpaulins. A 2-in. steampipe was run along the lower edge of the form.

The two 235-ft. reinforced-concrete stacks were tapered and so could not be built with ordinary slip forms. A special form was designed by the contractor which compensated for the taper as the height increased. The Rust Engineering Company, Pittsburgh, built the stacks.

The officers of the Lawrence Portland Cement Company in close touch with the building of the new mill were Frank H. Smith, president; Charles A. Porter, second vice-president; J. S. Van Middlesworth, secretary; and J. H. Van Middlesworth, purchasing agent. Mr. Porter was in active charge of the work at Thomaston. The actual design was carried out by the engineers of the Burrell Engineering & Construction Company, Chicago, with A. C. Brunner in charge. The Burrell company also furnished key men for the construction organization, these men being taken over by the Lawrence company as its employees during the course of the work. E. J. Davis is superintendent in charge of operation.

Mechanically Cleaned Bar Screen at Los Angeles Sewage Plant

Motor-Operated Rakes Sweeping Curved Bars of Screen Prevent Head Increase Attendant Upon Intermittent Cleaning

AFTER about three years of experiment and improvement, development is now believed to be completed on a self-cleaning bar screen at the Hyperion sewage plant through which the bulk of sewage from Los Angeles passes on its way to the ocean. An automatic rake of the improved type described in the following notes is now installed in the influent channel of both the north and the south plants at Hyperion. During the process of development, the device on which experiment was under way was in continual service at the north plant, and thus each change in the mechanism was tried out under operating conditions.

The north and south plants at Hyperion were designed, as was the system as a whole, with a view to preventing

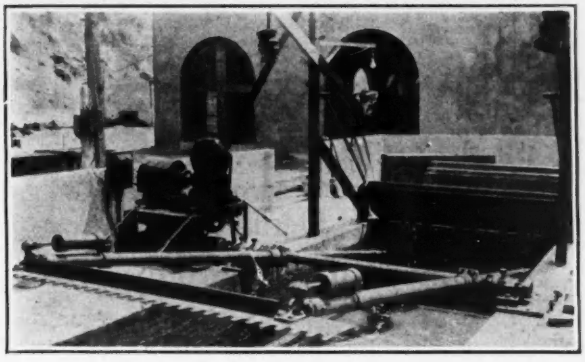


FIG. 1—MOTOR-OPERATED SCREEN RAKING DEVICE AT HYPERION

pollution of the ocean shore and beaches. The north plant now includes five Dorrco screens with a total capacity of 225 sec.-ft. and has space for the installation of five more screens of equal capacity to be added later. In the south plant the present installation is eight Dorrco screens with a total capacity of 120 sec.-ft. and with space for four more that would add 50 per cent to the capacity of the installation. (*Engineering News-Record*, June 3, 1926, p. 898.) Screened effluent from both plants is discharged into the Pacific Ocean a mile offshore through a 7-ft. outfall sewer. (*Engineering News-Record*, Aug. 20, 1925, p. 292.)

At the outset the influent channels at both north and south plants were equipped with inclined bar screens arranged for hand raking. While this was in line with practice elsewhere, these screens were the only parts of the plant that were not self-cleaning and which required manual labor for operation. In addition to the unsightliness and odor, the clogging of the bars between rakings caused the sewage to back up in the influent channel, often resulting in deposition of solids ahead of the screen and an increase in the age of the sewage before it reached the treatment plant. Head losses from 2 to 10 in. are not unusual at such screens; the necessary frequency of hand raking varies from day to day, particularly in a combined sewerage system, and the raking by hand is such a disagreeable job that operators are inclined to avoid it as much as possible. For these reasons determined effort was made to devise for the Hyperion plants a simple, foolproof, mechanically operated device that would keep the bar screens clear at all times and under varying conditions of flow.

The first practical device was installed at the north plant in 1925. Here the channel is 8 ft. wide and 11 ft. deep, designed for a peak flow of 200 sec.-ft. The bars are $\frac{1}{2}$ in. wide and spacings $1\frac{1}{4}$ and $2\frac{1}{2}$ in. apart both have been tried with success. The mechanism is driven at a speed of about one revolution in 3 min. by a 2-hp. motor but it is believed that inasmuch as the speed-reducing gears act as a governor during that part of the revolution in which the arms are propelled by the sewage stream, a motor of considerably less horsepower would suffice.

The bars of the screen are curved in the shape of a quadrant and are so placed in the channel that the incoming sewage flows against the concave side. The lower ends of the bars are secured to the bottom of the channel and the upper ends are attached to a structural member spanning it. The cleaning or combing mechanism consists of a pair of parallel arms mounted at their centers upon a motor-driven shaft which is parallel to the raking plates that join the outer ends of both arms. The center line of the driving shaft is located at the center of the circle of which the bars form a quadrant so that the raking plates, which are indented to form fingers dovetailing between the bars, are equidistant from the bars during their path of travel over them. Each raking plate is held in position by a spring-loaded safety hinge which

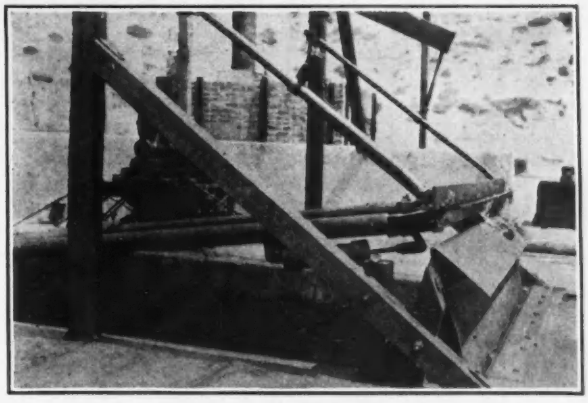


FIG. 2—SCRAPER-BAR CLEANING RAKE ABOVE THE SCREEN

allows it to swing backward so as to pass over any large solids lodged on the screen which might otherwise cause a breakage in the cleaning mechanism.

As the raking plates sweep upward over the curved bars, the fingers collect the accumulated solids and carry them up above water level to a metal apron, whose function, in part, is to squeeze the screenings against the raking plates and thus, together with the action of the scraper bar, to remove a considerable part of the contained moisture. After clearing the metal apron the screenings are pushed off the raking plate by the scraper bar. This bar is a structural member, longer than the raking plates, and carried on two counterbalanced arms which are free to swing through an arc centering in short shafts mounted on pedestals outside the arms of the cleaning mechanism.

Since the radius of the circle described by the scraper is much less than that of the circle described by the cleaning

mechanism, the scraper bar is given a radially outward motion with respect to the cleaning rakes as soon as it is lifted by them, all of which causes the screenings to be pushed bodily off the rakes and into a convenient receptacle for disposal. This operation is such that the scraper bar is moved upward and outward for a short distance by the cleaning rakes and then passes clear of the rake fingers and swings back by gravity to the starting position. The means of disposal of the solids raked off the screens is still the subject of investigation and experiment; meanwhile, like the screenings, the rakings are buried in sand dunes near by. A plant attendant who looks after and oils the mechanism removes the accumulated screenings several times daily.

At one time is was believed that it would be feasible to dispense with the driving motor and operate the cleaning mechanism (which then had four raking plates) simply by the pressure of the sewage flowing against the radial paddles. That the mechanism could be operated in this manner was demonstrated but the plan was later abandoned as not dependable under all conditions of sewage flow. The small amount of power required to do the work dependably represents an insignificant increase in the total operating cost.

During the three years that the unit has been in operation the changes in design have been of minor character; in principle the device is still the same as the original installation. Since all bearings and moving parts are above water level and move very slowly, it is believed that maintenance will be low. Because there is not time between the successive rotations of the arms for any material amount of solids to accumulate, the flow through the bars is attended by very slight loss of head. It is to be noted that this arrangement gives a considerable reduction in the necessary area of screening surface when compared to screens designed for hand-raking, and it is believed that narrower openings and hence finer screenings could be effected by the same means if desired.

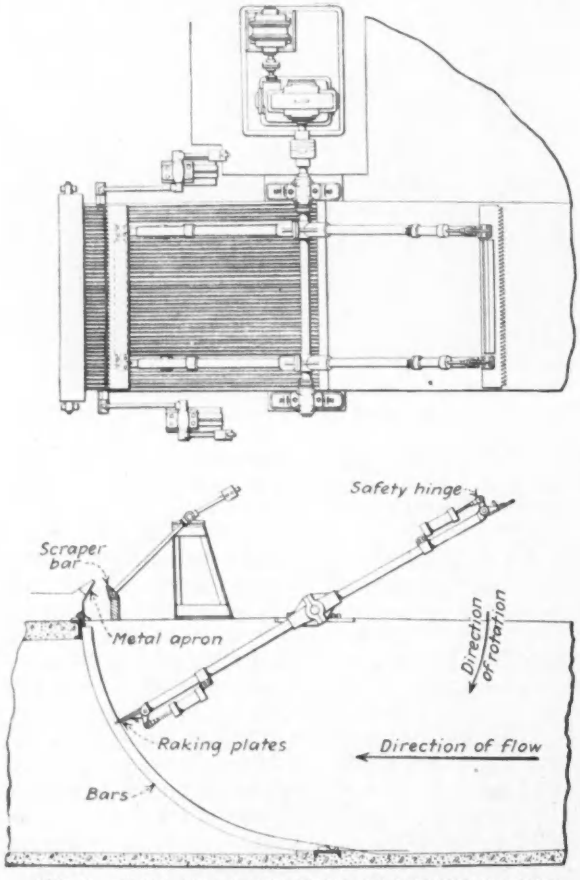


FIG. 3—PLAN AND ELEVATION OF RAKING DEVICE

While it is believed preferable to have the cleaning device operate continuously, especially at large plants, an arrangement has been developed which permits intermittent automatic operation where this may be desired. To accomplish this a diaphragm is placed in contact on one side with the sewage upstream from the screen and on the other side with the sewage on the downstream side of the screen. When the pressures on both sides of the diaphragm are equal the motor switch is held in the "off" position. When the loss of head increases to a predetermined maximum due to accumulated screenings the displacement of the diaphragm due to the unequal pressure on the two sides actuates the motor, which runs until the loss of head returns to a predetermined minimum. The setting for head differential may be made at 2 in., if desired, and thus automatically start the cleaning mechanism before the loss of head has been sufficient to interfere with the free flow of sewage.

The development of the automatic cleaning device was initiated under the direction of H. A. Van Norman, then city engineer of Los Angeles; later, the further development and perfection of the equipment was turned over to the Dorr Company, of New York City, which company is adapting it to sanitary installations of various kinds.

Full Storage Demanded Before Universal Metering at Colorado Springs

By Frank O. Ray
City Engineer, Colorado Springs, Colo.

A REPORT on the water supply and fire prevention of Colorado Springs in which metering was advised was recently made by the engineers of the National Board of Fire Underwriters. Although full metering will doubtless come in the future, conditions here dictate its postponement until our storage program, now under way, is completed.

The city is supplied by gravity from a limited mountainous drainage area adjacent to the city, which area cannot be extended without encroaching on areas now serving other municipalities. All water in Colorado is owned either through prior use or purchase. A complete plan for the development of our water system was made in 1916. It provides for the construction of a number of reservoirs to store practically all the available runoff from our drainage area. The land for these storage reservoirs has been secured, filings on the water have been made, and construction is in progress, and if these water rights are to be held, it will be necessary to continue this construction program as fast as possible. Practically all our water supply and storage is obtained at an elevation of 9,000 ft. or more above sea level, in a mountainous district with steep slopes, and costs about $300 per acre-foot, or $900 per million gallons.

The city owns both the water and the electric system. The electric system has a steam plant and two hydroelectric plants. One of the latter is operated under a

1,160-ft. head; the other under a 2,422-ft. head, using the water which has passed over the wheels of the other plant in addition to a supply from lower streams. These hydro plants are located on the supply lines of the water system, but use only sufficient water to care for the demands of the water department, on its way to the city distribution system. The electric department pays the water department for the use of all water passing through the hydro plants, at an agreed rate per kilowatt-hour of current produced, and all such water used is turned into the water mains at an elevation which maintains sufficient pressure in all parts of the city.

There is a high-pressure distribution system operating with about 165-lb. pressure and a low-pressure system

COLORADO SPRINGS STORAGE RESERVOIRS NOS. 7 AND 8
The reservoirs are at El. 12,100 and 11,700 ft.

with about 45-lb. pressure; these systems are connected with pressure-regulating valves. In addition to the domestic supply, water for irrigation of lawns and parks is furnished from direct stream flow through irrigation canals and low-pressure pipe lines. All large consumers are now metered, there being about 400 metered consumers out of a total of 13,000 consumers.

On account of the conditions outlined, we believe the proper plan for Colorado Springs to follow is to continue its storage development, and thus protect its water rights, until all available water in its collecting area can be used, and then meter the system.

Old Wooden Conduit Uncovered

Employees of the Chicopee (Mass.) water department, while at work laying new pipes, recently uncovered sections of wooden conduit which, according to existing records, must have been laid at least 80 years ago, when the region was still to a large extent covered with forest. The conduit is thought to have connected the settled portion of the village with a reservoir in the northern section, now long since disused.

The conduit was in sections averaging about 7 ft. long, with a bore of about 4 in. It was constructed of chestnut logs, roughly hewn on the outside and probably cut in the immediate vicinity. Officials of the department report that they still appeared serviceable.

It was found that since the wooden conduit was first laid several sections have been removed and replaced with iron pipe of smaller bore. This was connected directly to the woden pipe by enlarging the openings and driving the iron pipe into place. The installation of the iron pipe is believed to date back at least 50 years.

Coefficients of Venturi Meters and Reynolds' Criterion

By W. S. Pardoe
Professor of Hydraulic Engineering, University of Pennsylvania, Philadelphia, Pa.

IT IS this writer's belief that the coefficients of Venturi meters cannot be plotted against Reynolds' criterion $\frac{vdp}{\mu}$ and give any satisfactory result above the critical velocity.

Curves of coefficients published by J. W. Ledoux (*Proc.* Am. Soc. C. E., April, 1927) give a good opportunity to test this method of plotting. Fig. 1 gives this information plotted against log $\frac{vdp}{\mu}$. The result looks anything but encouraging. The variations from the average range up to 2 per cent. The average curve slopes up continually, although each individual curve becomes flat at a value of v from 10 to 15 ft. per second. (See

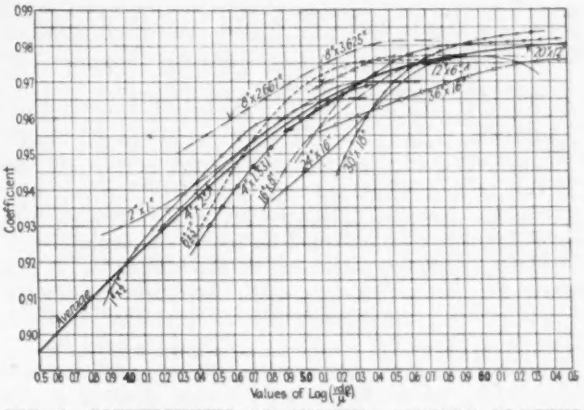


FIG. 1—COEFFICIENTS OF VENTURI METERS PLOTTED AGAINST REYNOLDS' CRITERION

also Fig. 2.) That is, if a curve for a given size is reproduced from the average curve, the coefficient will increase with the throat velocity.

To bring this out more clearly the writer tested a 3.981x1.631-in. Venturi meter up to a throat velocity of 110 ft. per second, as shown in Fig. 2. Note that the coefficient is 0.973 from 10 to 110 ft. per second. If Reynolds' criterion is correct, the coefficient of the 3.981x1.631-in. meter at 100 ft. per second, the 19.905x 8.155-in. at 20 ft. per second and the 39.81x16.31-in. at 10 ft. per second, would all be the same—that is, 0.937. All the experimental evidence available to the writer indi-

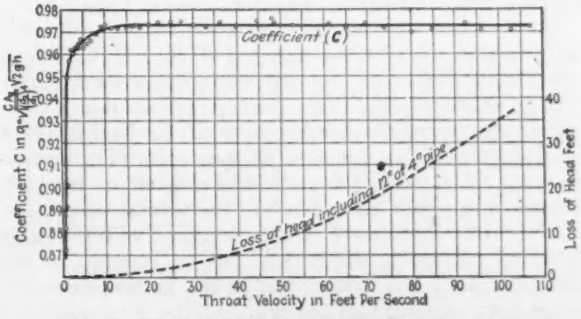

Coefficient (C)
Loss of head including 1/2 of 4" pipe
Coefficient C in q = CA√2gh
Loss of Head Feet
Throat Velocity in Feet Per Second

FIG. 2—TEST RESULTS OF VENTURI METER
The meter used was 3.981x1.631 in. The velocity range was from 10 to 110 ft. per second.

cates that the coefficient increases with the diameter and does not vary greatly with proportional roughness or viscosity. That is, there is a loss depending on the form of the meter which is greater than the computed frictional loss (see article by writer, *Engineering News-Record*, Sept. 25, 1919) and is independent of the surface roughness. Hence to obtain the coefficient of large Venturi meters we must still use a series of two or three model meters inside the capacity of our laboratories and extrapolate. Fortunately, the coefficients of the models vary up to 0.983 and the coefficient of the large meter cannot equal unity (in all probability it has 0.99 as a maximum); therefore the errors of extrapolation cannot be very great.

Both theory and experiment indicate that Reynolds' criterion can be used advantageously below the critical velocity or for stream-line flow.

Belt-Line Railroad Agreement for Los Angeles Harbor

Four Railroads and City Make Pact Providing for Joint Operation of Facilities That Include 123 Miles of Track

AFTER three years of preliminary work looking toward unification of rail facilities at Los Angeles harbor, an agreement turning all port rail trackage over to a harbor belt-line railway to be operated as a separate corporation has been signed by the Los Angeles Board of Harbor Commissioners and by the four railroads that reach the harbor—namely, the Southern Pacific, the Union Pacific, the Pacific Electric and the Atchison, Tokepa & Santa Fe.

Los Angeles grew into a city of the half-million population class before the opportunity for developing port facilities was utilized. In 1909 territory was annexed to bring within the city limits harbor facilities at Wilmington and San Pedro, Calif., about 25 miles from the center of the business district of Los Angeles. Construction of channels and terminals was begun in 1912 and the first municipal wharf was completed in 1914.

TRACKAGE AND VALUE OF BELT LINE

Owner	Track Mileage	Valuation
City of Los Angeles	57.1	$6,122,107
Southern Pacific	24.7	34,498,396
Union Pacific	26.8	9,530,516
Pacific Electric	17.1	7,776,712
Total	122.7	$57,927,732

At the time the belt-line agreement was signed early this summer the city had acquired or built 57.1 miles of track in the harbor district that was operated as a municipal terminal railway. This trackage is valued at a comparatively low figure, because most of the land involved was acquired from the state without cost. The accompanying table shows the value and amount of trackage brought to the belt line by each of the several signatories.

The Santa Fe Railway, while connected with the city's terminal railway at the harbor, has no trackage in the harbor district but participates in the agreement under terms that take this into account.

Under the agreement, management of the belt line is vested in a board of control and a board of operation, the former to consist of eight members, four representating the city and four representing the railroads. This body directs and controls operation and maintenance, subject to the board of control.

The city receives $1 for each revenue freight car switched by the belt line, regardless of whether it is switched over city tracks or not. The member railroad companies collectively receive $1 for each revenue freight car switched by the belt line. An additional sum of $5 is charged by the belt line for handling a car for any connecting railroad not a party to the agreement.

Engines and other equipment used in belt-line operation are rented from member railroad companies at the instance of the board of operation and at a rental fixed by the belt line. The belt line maintains all track and structures under its jurisdiction with the exception of tracks on city wharf structures, where maintenance is done by the city, the belt line being charged on a pro rata basis of the total wharf maintenance for the track facilities and substructures supporting them.

When the agreement became effective, each member company advanced to the belt line as working capital an equal sum of money, this being the start of a revolving fund to be used in carrying on the business of the line. Changes, additions and betterments recommended by the belt line are to be made by the party owning the facilities, except that additions and betterments of major importance which involve the acquisition of real property are to be financed by methods to be mutually agreed upon by the belt line, the city and the member companies.

Surplus or deficits resulting from belt-line operation are to be distributed among member companies on the basis of the number of cars handled for each member. A joint freight agency to conduct all necessary station work for the belt line and member companies was established by the board of operation, and expenses of this joint agency are included in general operating expense. The belt line, however, is not to solicit line haul traffic and all its employees shall be neutral in respect to all member companies.

During the first year of the agreement terminal switching rates are to remain the same, but cost records are being kept and an adjustment in switching rates is to be made at the end of each year. No charge is to be made for the movement of empty cars and freight for railroad companies or the city is to be handled free.

It is intended that the agreement shall be of continuous and lasting character, but to provide for unforeseen conditions it contains a clause providing for termination at any time after the first three years by mutual consent of all parties thereto. After five years any party to the agreement may withdraw upon two years' written notice, thus making the agreement in effect a seven-year contract.

Texas Water- and Sewage-Works

To assist Texas municipalities in keeping up the standard of their water supplies and sewage-works, the bureau of sanitary engineering, in the State Board of Health, invites monthly operating reports which show the status of such works with regard to their sanitary features. About 33 towns and cities now make regular reports on their water-works operation, and a smaller number on their sewage-works operations. Plans for new works and the improvement of existing works are also submitted to the bureau for inspection. V. M. Ehlers is director of the bureau of sanitary engineering.

Jadwin Flood-Control Plan Approved by Special Engineer Board

Board Appointed by President Coolidge to Review Flood-Control Plans Prepared by the Mississippi River Commission and the Chief of Engineers, U. S. Army, Approves the Latter Plan in a Report Submitted to the President—Cost Figures Raised to $318,500,000

UNQUALIFIED approval of the plan prepared by Major Gen. Edgar Jadwin, Chief of Engineers, U. S. Army, for the control of floods in the Mississippi and its tributaries has been given by the board of three appointed by President Coolidge to study that plan in comparison with one prepared by the Mississippi River Commission, and to report to him as to its recommendations upon all points in which the two reports differ. The board consists of Major Gen. Edgar Jadwin, Chief of Engineers, U. S. Army, Brig. Gen. Thomas H. Jackson, president of the Mississippi River Commission, and Carleton W. Sturtevant, consulting engineer, New York.

By an "Act for the Control of Floods on the Mississippi River and Its Tributaries" approved by Congress May 15, 1928, the flood-control plan submitted by the Chief of Engineers was adopted and authorized to be prosecuted under the direction of the Secretary of War and the supervision of the Chief of Engineers. The act provided, however, that a board to consist of the Chief of Engineers, the president of the Mississippi River Commission and an engineer chosen from civil life be appointed and directed to "consider the engineering differences between the adopted project and the plans recommended by the Mississippi River Commission in its special report dated Nov. 28, 1927, and after such study and such further surveys as may be necessary, to recommend to the President such action as it may deem necessary to be taken in respect to such engineering differences." The decision of the President upon such recommendations is to be followed in carrying out the project approved by Congress. The bill also included a provision making it possible for the late Brig. Gen. Charles L. Potter to be retained as president of the Mississippi River Commission, so that he could sit upon the board which was to review the plan prepared under his direction (General Potter then being past the retirement age); but the President did not avail himself of this provision and General Potter was retired and General Jackson appointed president of the commission to succeed him.

Soon after the board had been organized it made a trip through the alluvial valley of the Mississippi River and held hearings at various places in order to afford local interests an opportunity to express their views. Locations of the proposed flood-control work were examined and the topography of the valley observed. Surveys were made to obtain additional data at certain places that are critical in the plans under consideration by the board and experts on hydraulic questions were freely consulted. The board states that the results obtained by several disinterested experts were so closely in agreement as to preclude errors having any practical bearing on the questions involved. In each case the adopted project, that prepared by the Chief of Engineers, was found to have been so formulated as to have the proposed work on the safe side with reference to variations in basic data.

Engineering Differences

The board found that the two plans were in close agreement in principle on at least 75 per cent of the actual construction necessary and in partial agreement on the remaining 25 per cent. Only upon a few points was there a pronounced difference, but as some of these points are of major importance the board examined them in considerable detail before writing its report. In comparing the plans the board stated that both plans provide for some increase in the carrying capacity of the main river by a moderate raising of the levees through nearly the entire length of the alluvial valley. Both contemplate the passage of a large amount of water down the alluvial valley on the west side of the Mississippi River from the Arkansas River to the Gulf of Mexico, but they differ as to quantity. Both provide for a spillway on the east side of the river above New Orleans at Bonnet Carré. The differences are primarily differences in capacities and amounts, rather than in engineering principles, according to the board's findings, as given in part in the following extracts:

The adopted project provides protection against the greatest flood predicted as possible. If such protection is to be afforded, little, if any, of the adopted plan can be omitted or essentially modified. The plan recommended by the Mississippi River Commission provides for protecting against a lesser flood, or one about equal to that of 1927. It is obvious, therefore, that this plan is deficient throughout if protection against the predicted flood is to be given.

One principal difference between the two plans is that the adopted project carries the surplus flood water from Cairo to New Madrid in a floodway and with a higher levee at New Madrid, while the commission's plan does not provide such a floodway but provides for a lesser flood which is to be carried in the main river with no levee raising at New Madrid. In other words, for this stretch of the river the adopted project provides a wider channel and higher levee at New Madrid, while the Mississippi River Commission plan contemplates a channel of the present width with the same levee raising at Cairo and no levee raising at New Madrid.

The adopted project contemplates leaving, as it exists, a sufficient width in the Boeuf River Basin to carry all water of a superflood in excess of what the main channel will carry and to give complete protection to all other areas in this general latitude, while the plan of the Mississippi River Commission prescribes a floodway in the Boeuf River Basin with a capacity of 600,000 sec.-ft. but raises the main river levees only enough for both floodway and main channel to carry a flood about equal to that of 1927.

Below the mouth of the Red River the plan of the adopted project leaves as they exist sufficient areas in the Atchafalaya Basin to carry all water predicted as possible in excess of what the main river is to carry, while the Mississippi River Commission's plan provides for removing an existing levee at the head of the Atchafalaya Basin and having a floodway below of width sufficient to carry, together with the main river channel, a flood about equal to that of 1927.

Upper River—From Cape Girardeau to Birds Point, on the west side of the Mississippi River, the two plans in question are identical.

The adopted project provides for the inclosure of Cairo, Ill., with levees at El. 60 on the Cairo gage. The commission plan does not state what it contemplates for Cairo. It is evident that the levees surrounding Cairo should be raised to the elevation named in the adopted project.

From Birds Point to New Madrid, Mo., the floodway provided for by the adopted project will hold the maximum flood predicted as possible to 59 on the Cairo gage and 1 ft. below the proposed levee height. This will give a reasonable degree of safety to Cairo, with its 15,000 inhabitants. In addition, this floodway, by reducing flood heights, will render the St. Francis Basin in southeast Missouri and Arkansas less liable to an accidental crevasse due to excessive flood heights. The riverside floodway plan offers the best solution for the situation at Cairo and vicinity, because it gives a greater lowering of the flood plane than any other practical plan and provides greater safety to more property and lives. It is the one desired by the greatest number of those vitally interested. The commission plan raises the levees opposite Cairo 2 ft., the same as the adopted plan, but makes no provision against a superflood.

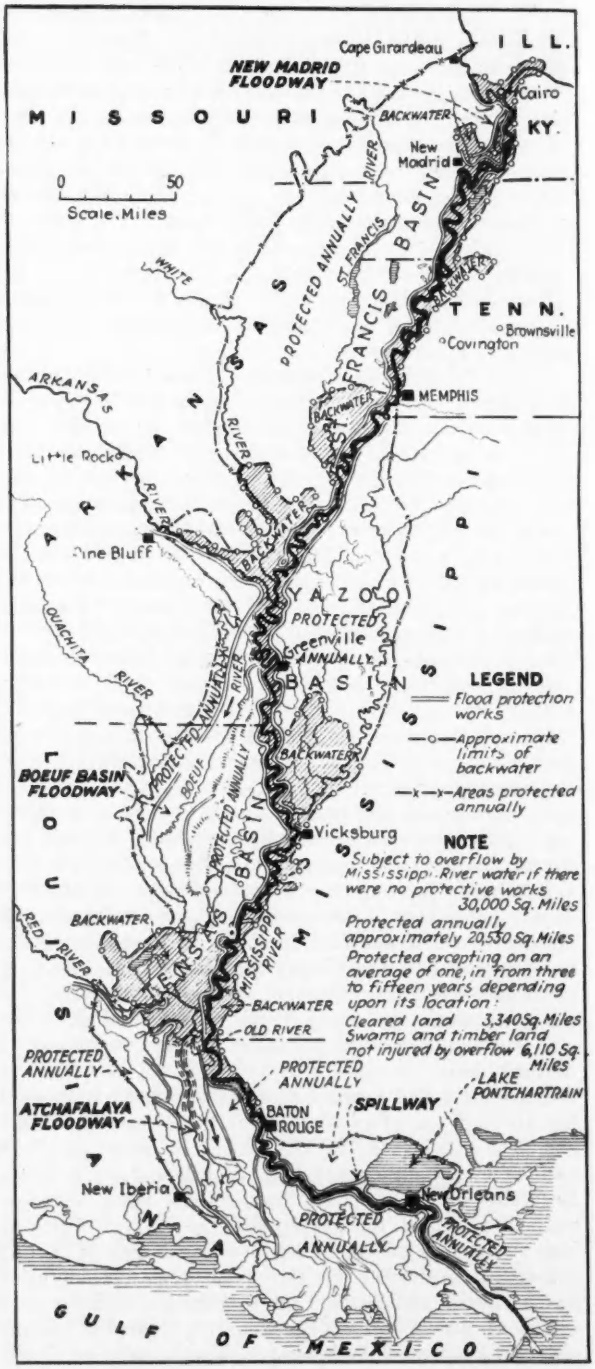
A public hearing was held at New Madrid, Mo., at which the proposed Birds Point-New Madrid superstage floodway was freely discussed. If about 450,000 sec.-ft. should be allowed to pass out of the river channel, the resulting gage height at Cairo would be about 59. All experts have found that the stretch of minimum capacity of the floodway would carry this amount or more. One expert expressed it by saying that the critical stretch, uncleared, would carry 150,000 sec.-ft. and if cleared it would take about four times this amount (600,000 sec.-ft.). The stretch in question is cleared and will undoubtedly remain cleared, so there need be no apprehension about its accommodating 450,000 sec.-ft., which amount taken out of the river in a superflood will hold the Cairo gage to about 59. The plan of the adopted project proposes to permit water to spill into the floodway at stage 55 Cairo, so that great floods of lesser volume than the maximum flood will also be reduced in height. The 1927 flood actually produced a stage of 56.4 at Cairo without accident, and an equal flood under the plan of the adopted project will produce a stage of about 55½ for a short time only. It should be remembered that a flood approximating in volume the maximum predicted as possible can occur, according to predictions, on the average only once in 200 years.

Middle River—From the mouth of the Arkansas River to the mouth of the Red River, the adopted project provides for the maximum flood predicted as possible; prescribes the minimum levee raising consistent with retention of existing protective works; uses a relief fuse plug levee at existing height instead of an expensive uneconomical masonry spillway, controlled or not controlled; and insures that the natural auxiliary path for flood waters will perform its functions by leaving it wide enough to carry, in an uncleared condition, all excess water that may flow into it. An uncleared relief channel is cheaper in first cost and maintenance and is more dependable than a cleared one.

The lands that will be left subject to natural overflow in the plan of the adopted project for the Boeuf Basin are about 75 per cent swamp and timber lands. They are to retain their existing protection. The adopted project provides for as much protection and reclamation as is justified economically. Additional reclamation of such lands as lie within the bounding levees of the adopted project and outside those of the Mississippi River Commission plan is not warranted.

The part of the basin that is cultivated can usually produce a crop after an overflow which, according to estimate, will occur on the average about once in twelve years. The only advantage to such lands of a masonry spillway would be that the flow would be stopped on a falling river at the crest of the spillway instead of at bankfull stage, as will be the case with fuse plug levees. This would mean that planting after the overflow could be made somewhat sooner than if it had to wait until the river fell to bankfull stage. The advantage does not justify the cost.

Since public attention has been focussed on flood control, there has been a great deal of discussion about controlled spillways. For the head of the Boeuf Basin, the Mississippi River Commission planned a masonry spillway with a fixed crest, but stated that controlling gates could be installed if desired. A so-called controlled spillway would probably not be really controlled as well as a fuse plug levee, since the operation of it would be subject to human judgment in times of hysteria; people above it would want it opened too soon and people below it would want it left closed too long; public hearings might have to be held



MAIN FEATURES OF ADOPTED FLOOD PROTECTION SYSTEM

Hatched areas indicate submergence from backwater at lower ends of flood basins in occasional years. Dash lines show boundary of protected areas. This map is reprinted from an abstract of the Chief of Engineers' report on flood control published in *Engineering News-Record*, Dec. 15, 1927.

before it could be opened; injunctions might prevent it from being opened at all.

Lower River—Below Red River the plan of the adopted project provides for a superflood estimated at 3,000,000 sec.-ft. The Mississippi River Commission estimates for a maximum probable flood of 2,650,000 sec.-ft., but its recommended plan does not protect against such a flood.

The adopted plan provides for leaving the levees at the head of the Atchafalaya Basin as they exist, so that such lands as are usable behind them may continue to be used.

The Mississippi River Commission's plan proposed a floodway only on the west side of the Atchafalaya River. The levee at the head of this floodway is to be torn down and the lands in the floodway are to be subject to overflow whenever the river rises above bankfull stage, which will mean almost every season. Simmesport, Melville and other small towns in the floodway are not to be protected and they would necessarily pass out of existence. This would be economic waste. The commission floodway, including the Atchafalaya River, can carry only 900,000 to 1,000,000 sec.-ft. and the remainder of the flood waters will have to go down the main river or break levees and overflow the valley.

The commission recommends that the levees on the main river be raised from 2½ ft. at Angola to zero at Donaldsville. The capacity of the river provided by this raising will not carry, with the Atchafalaya floodway, the flood estimated by the commission as the maximum probable (2,650,000 sec.-ft.), much less the maximum predicted flood used in the adopted project. The report of the commission shows that it had in mind an extension of its recommended plan at some future date to protect against a greater flood. This extension was in the form of further raising of the main river levees and the construction of a spillway at Caernarvon, below New Orleans. This extension, plus the recommended work, would cost more than the adopted plan and would also increase the highwater velocities at New Orleans.

Mappings—The existing maps of the Mississippi River are very accurate. There is one on a scale of 1:63,360 and another on a scale of 1:20,000 (one inch to one mile and three inches to one mile). These are based on a control of triangulation and precise levels. There is also an accurate map of the alluvial valley on a scale of one inch to five miles which is intended to show principally streams and areas subject to overflow. In addition, there are many other maps of parts of the alluvial valley containing various degrees of detail. The drainage surveys that have been made by local interests are especially prolific in elevations. There is no general contoured map of the valley, although contoured maps of some parts of it have been prepared. Most of the existing maps have been made for planning and construction purposes and are therefore more accurate and contain more detail than the ordinary topographic contoured map. Since contoured maps can be provided on an economic basis by compiling data already on hand, supplemented with additional surveys where needed, it is advisable to prepare some such maps for general use.

General—In considering the plan recommended by the Mississippi River Commission, the board referred to and studied the report of the commission which contained a comprehensive plan estimated to cost $775,000,000 which was not recommended. The commission recommended that studies be made to determine the economic and engineering features about which it felt too uncertain to be willing to recommend a comprehensive flood-control plan. This board feels that the data available are sufficient to determine upon a general comprehensive flood-control plan; that extensive additional studies are not necessary for that purpose at this time; that the Mississippi River Commission's $775,000,000 comprehensive plan is not advisable; that the adopted project is, all things considered, the best comprehensive plan that can be formulated. The project permits such modifications of the plan as in the discretion of the Secretary of War and Chief of Engineers may be advisable, so that any change which is shown by detailed location surveys to be expedient can be made.

Cost Figures—An estimate of the cost of the proposed work compiled under the direction of the Chief of Engineers from estimates prepared by the district engineer is given in the report. It includes cost of construction and other items which are made definite by the law. Such indefinite provisions which may require legal interpretation and so are not susceptible of being accurately estimated at this time are not included. These provisions are chiefly concerned with flowage rights. The total cost is placed at $318,500,000.

ESTIMATED COST OF FLOOD-CONTROL WORK

Cape Girardeau to Arkansas River:	
Mississippi levees, including levee work around Cairo and certain levees necessary to keep water out of St. Francis Basin	$58,000,000
Rights-of-way floodway levees	250,000
Flowage floodway	2,550,000
Arkansas to Red:	
Mississippi levees	59,300,000
South bank Arkansas	5,000,000
Rights-of-way on Arkansas	350,000
Boeuf Basin levees	10,000,000
Rights-of-way Boeuf Basin	700,000
Ring levee and right-of-way Arkansas City	350,000
Below Red River:	
South bank Red	3,000,000
South bank Red rights-of-way	150,000
Bayou des Glaize setback rights-of-way	1,000,000
Mississippi levees	18,700,000
Atchafalaya River levees, revetment, rights-of-way	5,000,000
East Atchafalaya Basin protection levee	12,600,000
West Atchafalaya Basin protection levee	17,300,000
Rights-of-way protection levees	750,000
Ring levees and rights-of-way, Simmesport, Melville and Morgan City	1,000,000
Construction Bonnet Carré	8,200,000
Rights-of-way, flowage and damages Bonnet Carré	3,300,000
Revetments	80,000,000
Contraction works	20,000,000
Dredging	10,000,000
Mapping	1,000,000
Total	$318,500,000

Conclusions of the Board

In conclusion, the board states that it is of the opinion that no plan should be considered adequate that does not protect against the great flood predicted as possible; that the best solution of the Cairo situation is one which provides for holding flood heights and levee heights to a minimum; that nature should be permitted to continue to find relief through the Boeuf and Atchafalaya basins; that flow in the main river can be limited to that which can be provided for by a reasonable increase in levee heights; that fuse plug relief levees at existing levee heights provide the best solution of the spillway problem; that the present levee sections should be increased materially, but on a basis of design adapted to meet local material and foundation conditions; that present improvement of the navigable channel below Cairo, Ill., by dredging should be supplemented by the use of contraction works; and that needed contoured maps should be prepared from existing data, supplemented with surveys when necessary. The Chief of Engineers' plan meets the above requirements and at the same time is economical, the board states.

Recommendations—In view of its conclusions, the board recommends to the President that the plan prepared by the Chief of Engineers be adopted. The major features of this plan as outlined by the board are as follows:

Protection is to be given in the upper river (Cape Girardeau to Arkansas River) against the superflood equivalent to a confined flood of 66 ft. on the Cairo gage, which corresponds to a discharge from 2,250,000 to 2,400,000 sec.-ft.

Below Cape Girardeau the levee is to be raised from zero at that point to 2 ft. at Birds Point.

The Cairo City levees are to be strengthened and raised to a height equivalent to 60 ft. on the gage.

A setback floodway is to be provided from Birds Point to New Madrid capable of carrying about 450,000 sec.-ft.

The levees between New Madrid and Arkansas River, except opposite the backwater areas of the St. Francis and the White, are to be raised to a grade line equal to one foot above the flow line of the maximum flood as predicted.

Protection is to be given in the middle river (Arkansas to Red) against a superflood equivalent to a confined flood of 74.5 ft. on the gage at Arkansas City. The main river is to carry about 1,950,000 sec.-ft. All excess over this is to pass through fuse plug levees into Boeuf Basin. The protecting levees in Boeuf Basin are to be wide enough apart and high enough to retain all water that can pass with stage of 62.5 Arkansas City gage. The backwater curve computed with superflood peak stage of 62.5 is one foot below levee grades.

The levees of the main channel are to be raised an average of about 3 ft.

Protection levees in the Boeuf Basin are to be located as outlined in the adopted project. Monroe and Arkansas City are to be inclosed with ring levees.

Fuse plug levees of length of 20 miles or more are to be left about as they exist in the levee line, with no reduction in height.

Protection is to be given in the lower river (Red River to Gulf) against the superflood of 3,000,000 sec.-ft. Of this, 1,500,000 sec.-ft. is to go down the main river and the balance is to pass into the Atchafalaya Basin.

The levees on the main river are to be raised 3 ft. from Angola to Bayou Sara, from which point the raise in grade will decrease to zero at Bonnet Carré.

250,000 sec.-ft. are to be removed from the river at the Bonnet Carré diversion.

On the west side of the Atchafalaya, the Bayou des Glaise levee, extending from the backwater of Red River through Moreauville to just east of Bordelonville, is to be raised and strengthened. That part of the Bayou des Glaise levee east of Bordelonville is to be set back to a line practically direct to about Hamburg.

The present Atchafalaya River levees with their head extensions along Old River to the east and along Bayou des Glaise to the west are to be maintained as fuse plug levees at present heights.

Morgan City, Melville and Simmesport, within the floodway, are to be inclosed in part or in whole by levees.

The low water navigable channel in the river below Cairo is to be improved by contraction works.

Needed contoured maps of the alluvial valley are to be provided.

Land Needed for Overflow

In conclusion the board invites attention to existing conditions with reference to backwater areas. The adopted project proposes to allow the Mississippi River more room by raising levees and not attempting to exclude it entirely from all its natural flood areas. At the same time various local interests are naturally desirous that levee lines be extended so as to reclaim additional backwater areas. Such reclamations take flood space from the river. We cannot keep taking space from the river and at the same time give it the room it requires except by allowing it space elsewhere, either vertically or horizontally. To construct works to allow the river the flowage room it needs, as we are now doing, and at the same time take land from it elsewhere before these works are constructed, is not a consistent procedure. It is possible that in the future so much land in the flowage areas may become cleared that the resulting velocities will reduce flood heights and thus permit additional reclamation.

An abstract of the Chief of Engineers' plan was given in *Engineering News-Record*, Dec. 15, 1927, p. 961, and of the Mississippi River Commission's plan in the issue of Dec. 22, 1927, p. 1006. A comparison of the cost of the two plans, written by the late Brig. Gen. Charles L. Potter, was given in the issue of Jan. 5, 1928, p. 27. —Editor.

Wear of Brick Pavement Under Heavy City Traffic

Traffic of 3,000,000 Tons Per Foot of Width Reduces Thickness an Inch—Bureau of Public Roads Tests Misleading

By P. L. Brockway
City Engineer, Wichita, Kan

This Article gives supporting evidence of the considerable abrasive wear of brick pavements under modern rubber-tired vehicle traffic. Other records covering a much larger mileage of pavement and a longer period of service were given by R. L. Simpson, city engineer, Columbus, Ohio, in *Engineering News-Record*, March 25, 1926, p. 480, and Sept. 30, 1926, p. 551. —Editor.

In a test of wear of brick pavement at Arlington, Va., a few years ago under the supervision of engineers of the U. S. Bureau of Public Roads, one conclusion drawn was that the traffic, and presumably the wear and breakage of brick by the passing vehicles, were equivalent to fifteen or twenty years on the heaviest traveled highway in Cook County, Illinois. This conclusion did not carry conviction to those who had observed pavement in use over a period of years. It is interesting, therefore, to note a specific instance of wear under actual traffic, at Wichita, Kan.

In 1912 one block of pavement was constructed in the approach to a subway under railroad tracks. On a 6-in. concrete base was a cushion of about 1½ in. of sand, without cement. The wearing surface was wire-cut brick blocks (called vertical-fiber blocks in Mid-West territory), 4x4x8 in., laid with one rough face up and with asphalt filler having a penetration of 30 to 35 at 77 deg. F. The blocks were very uniform in color, toughness and shrinkage. A square-shot rattler was used in testing, all brick safely passing below the limiting maximum loss of 16 per cent.

The total width of pavement is 81 ft., with a double-track street-car line in the center. Diagonal parking has always been permitted. No vehicular traffic is allowed under the subway on the car tracks. From 35 to 33 per cent of the traffic makes right or left turns at the nearest street intersection 300 ft. from the subway. Deducting 20 ft. of street-railway pavement and 30 ft. occupied by two lines of parked cars leaves about 30 ft. of effective width. Traffic counts show daily traffic well above 15,000 vehicles, with almost no horse-drawn vehicles included. The diagonal parking in the center of the block forces nearly all vehicles to swing to right or left and back again in traveling the short distance. Traffic signals at the intersection already mentioned, together with the unavoidable tangle of right and left turns, causes a great deal of acceleration and deceleration of vehicles. About 20 per cent of the vehicles are trucks passing from industries to freight houses, with 2 to 4 tons per load in one direction. Climatic conditions are such that tire chains are almost never used.

It is apparent that there are at least 5,000,000 vehicular movements per year at the present time, involving at least 7,000,000 tons of traffic. The city has almost exactly doubled in population since the pavement was constructed. Assuming that traffic has increased directly with the growth of the city (which is conservative, because increasing congestion had forced much traffic away

before counts were made), the average annual traffic for sixteen years is 75 per cent of the present traffic, or a total movement during the entire time of 60,000,000 vehicles carrying 100,000,000 tons. These total figures are necessarily approximated, but they are believed to be conservative.

On this basis, 3,000,000 tons per foot of effective width has passed over the pavement. A service trench across the street has recently disclosed the fact that the brick have been worn down almost exactly 1 in. in the portion subjected to traffic, so that they are now 3 in. thick. The wear is very uniform, the surface remaining smooth. Close inspection discloses a flattening of the crown due to wear, but not sufficient to pocket water anywhere. No one would say that this is unsatisfactory service; in fact, it is remarkable that any material will survive so long under such punishment. But if 3-in. brick had been the style, the pavement would now be breaking up, having worn down to 2 in.; whereas it is good for at least ten and probably fifteen years more, while traffic grinds off another inch. It would seem that the paving-brick industry made a mistake in abandoning repress blocks for wire-cut blocks. Our experience indicates that the rough surface of the latter is much more easily worn than the glazed surface of the old-style blocks.

The Arlington test is open to criticism in several details, so far as results can be translated into service conditions as they obtain in ordinary streets and highways:

1. The brick were obviously picked with the greatest care to obtain the most perfect specimens, having extremely uniform color, size, shape and toughness. No specification could obtain so great perfection in commercial quantities, and no manufacturer could produce them at any reasonable price.

2. The pavement was laid to the highest degree of smoothness and even bearing. While such perfection should be and is the aim of all conscientious road builders, most pavements are only as good as the average workmen can make them. Extreme precision costs more than is warranted by resulting benefits.

3. The curves in the test road were superelevated to keep the center of gravity of the load over the center of support and so make the loads even on the inside and outside wheels. This avoids side thrust on the pavement of the turns, the surface being normal to the resultant of gravity and centrifugal force. Streets and roads cannot be built in that way. Terrific side thrusts must be absorbed by friction between rubber tires and pavement in the dodging traffic in any busy street or highway and especially in and near short-radius turns.

4. The speed maintained during the test could not well have been other than very uniform. There were no grades, nothing but the necessary tractive effort to maintain a moderate speed. The net result was little more severe than a straight rolling contact between rubber and brick. Certainly it could not compare with the conditions in the street which has just been described. Traffic in unobstructed highways pounds along at 35 to 40 m.p.h., with constant attention to brake and accelerator. In congested traffic the speed is less, but braking and accelerating are in more constant use. This condition alone should increase the wear per vehicle or per ton as compared with that obtained in the Arlington test.

Without discrediting in any way the paving material, the methods employed or the observations during the test, one is forced to the conclusion that the translation of the wear per vehicle to conditions of street or highway service was unwarranted, and that actual service tests will not support it. The use of thin brick on secondary streets or roads is justified, because traffic is never heavy and total friction is accumulated very slowly during the passing years. The great majority, indeed, of streets and roads come within this classification, so that the extra cost of thicker brick is not justified. But traffic does wear out pavement in direct ratio to volume and in increasing ratio with density, so that extra thickness is a decided economy in such locations.

Chicago Builds $600,000 Garbage-Incinerating Plant

Six Furnaces Give Capacity of 600 Tons of Refuse Daily—Cranes Carry Material From Pit to Charging Hoppers

FOR the disposal of garbage and refuse collected in the northwest section of Chicago, an incinerator having a daily capacity of 600 tons was put in operation in June. Its site is on Goose Island, in the north branch of the Chicago River, near Division St., in an industrial district.

The building, shown in Fig. 1, has an inclosed driveway along the front, with a low roof. In the more lofty portion are the furnaces. Parallel with the driveway is a deep pit into which the motor trucks and trailers discharge their loads by side dumping. Behind this pit are six 100-ton furnaces arranged in three batteries and served by three tall smokestacks. The pit and furnaces are spanned by four 3-ton electric traveling cranes, each carrying a 2-yd. grab bucket, by means of which the material from the pit is carried to the charging troughs on the furnaces.

A charging trough extends the full length of the top of each furnace, at right angles to the pit, and in the bottom are 1-yd. hoppers opening into the furnace, the gates of these hoppers being operated by pneumatic cylinders controlled from the stoking floor by the firemen. Fig. 2 shows a train of trailers at the left, and a grab-bucket taking a load from the storage pit. At the right

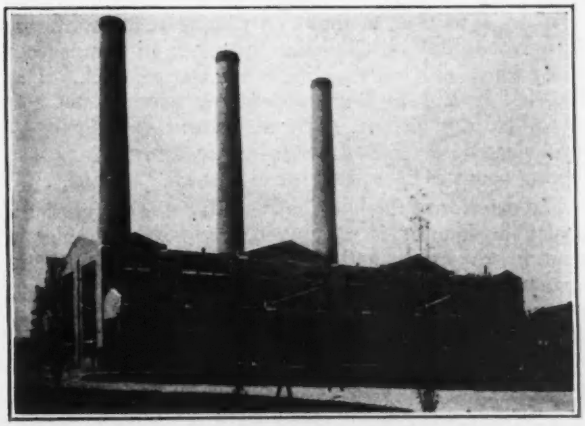


FIG. 1—CHICAGO GARBAGE-INCINERATING PLANT
Low front portion is covered driveway for garbage trucks and trailers. Furnaces in higher portion, with smokestacks at the rear. At left of building is steel bin for ashes.

and partly concealed by the pit wall are the furnaces. While much of the material is wet stuff, such as vegetables and fruit, and much of the paper is wet, there is also a large quantity of dry wood from broken fruit crates and barrels, making good fuel.

These furnaces are designed for continuous operation. When one cell is clean, there is no necessity of starting a new fire, as the adjoining cells contain fire with which the new cell can be started. Waste heat from the furnaces passes through preheaters which heat the air coming from the forced-draft fans on its way to the space beneath the grates. In this way the air is heated to 300 or 350 deg. F. Oscillating baffles within the combustion chamber increase the velocity of the gases and give greater activity to the heat and flames. All grates are of the shaking type. Each charging hole has a secondary straight thimble, outside the hopper, which can be lifted to give an opening sufficiently large to admit dead animals, but it is not intended to burn animals at the Chicago plant.

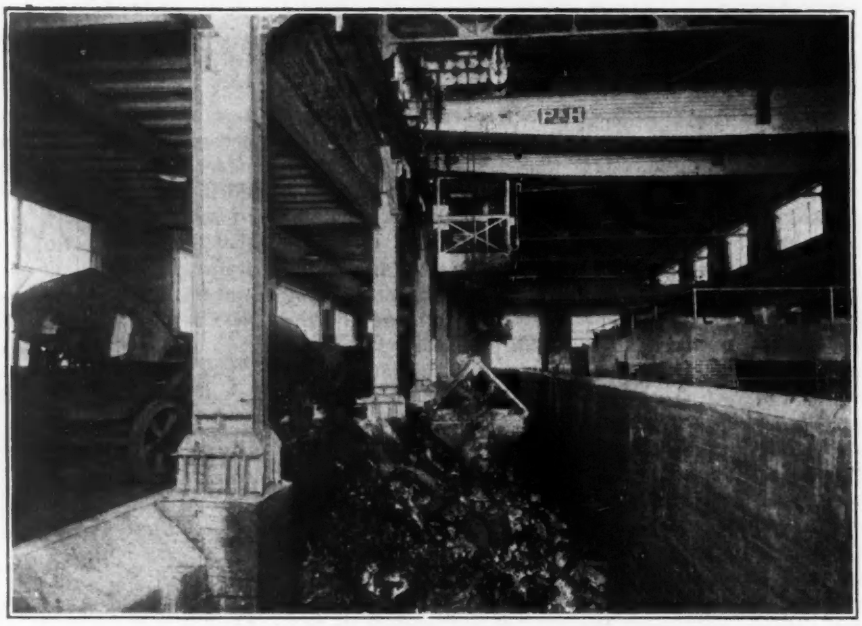


FIG. 2—INTERIOR OF INCINERATOR BUILDING
Storage pit in middle, with driveway at left and furnaces at right. Overhead traveling cranes with grab buckets deliver garbage and refuse to charging hoppers over the furnaces.

Ashes, cans and other residue fall into sloping ash-pits, which discharge into small cars. These cars are moved by hand to the ash hoist and are dumped into buckets, which deliver the material to an elevated bin. Two inclined spouts with chain-operated gates discharge the material into trucks and trailers to be hauled away and used for filling. The smokestacks, of a no-tension design, are of buff radial hollow brick with a height of 150 ft. above grade at top of footings. The flaring base has an outside diameter tapering from 18 ft. at the footing to 15 ft. 10 in. at 15 ft. and 14 ft. 8 in. at 35 ft. Above this there is a lighter taper to 10 ft. 4 in. diameter at the top, which has a cast-iron cap. A lining of firebrick gives an interior diameter of 15 ft. 6 in. at the base and 7 ft. 9 in. at top. This lining reduces from a thickness of 13½ in. to 4½ in. and gives an annular air space which reduces to 3 in. at the top of stack. The firebrick is laid in high-temperature cement, and the stacks are designed to stand temperatures of 2,500 to 3,000 deg. F. Wood piles support a reinforced-concrete footing about 24 ft. square for each stack.

The exterior of the buildings and stacks is of light buff brick; the interior is of gray concrete with aluminum paint for the cranes and metal work, thus giving a light appearance. The driveway is kept clean by frequent sweeping and flushing. In front of the building is a parkway, laid out with lawns and drives. There is little odor at the storage pit, the material not being allowed to accumulate, and there is little smoke from the stacks. As a matter of fact, the smell from the foul black and sluggish water in the river is more in evidence than that from the incinerator plant. At present, however, the spouting of ashes into trucks causes great clouds of dust, so that some means of overcoming this objectionable feature is desirable.

This incinerator plant, costing about $600,000, was designed and built by the Superior Incinerating Company, Dallas, Tex., and the smokestacks by the M. W. Kellogg Company, New York. The operation of the plant is in charge of the bureau of street cleaning. Loran D. Gayton is city engineer of Chicago.

New Rome-Naples Direct Railway in Italy

RAILWAY relocation on a large scale is being carried out by the Italian State Railways in order to supplement old circuitous and unfavorable routes by direct lines between important cities. The first of these direct routes, from Rome to Naples, was opened a few months ago. It shortens the distance from 155 to 133 miles, eliminates a succession of heavy grades and high summits, reduces curves both in sharpness and number, and its highest summit is 676 ft. lower than that of the old line. A plan and profile of the old and new lines are shown in Fig. 2. As originally completed in 1863, the old line had a length of 170 miles, according to the *Rail-*

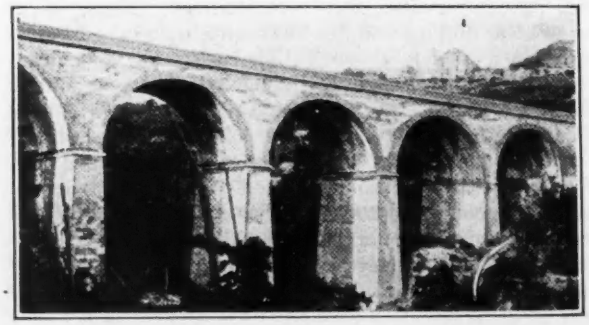


FIG. 1—STONE VIADUCT WITH SIX 46-FT. ARCHES

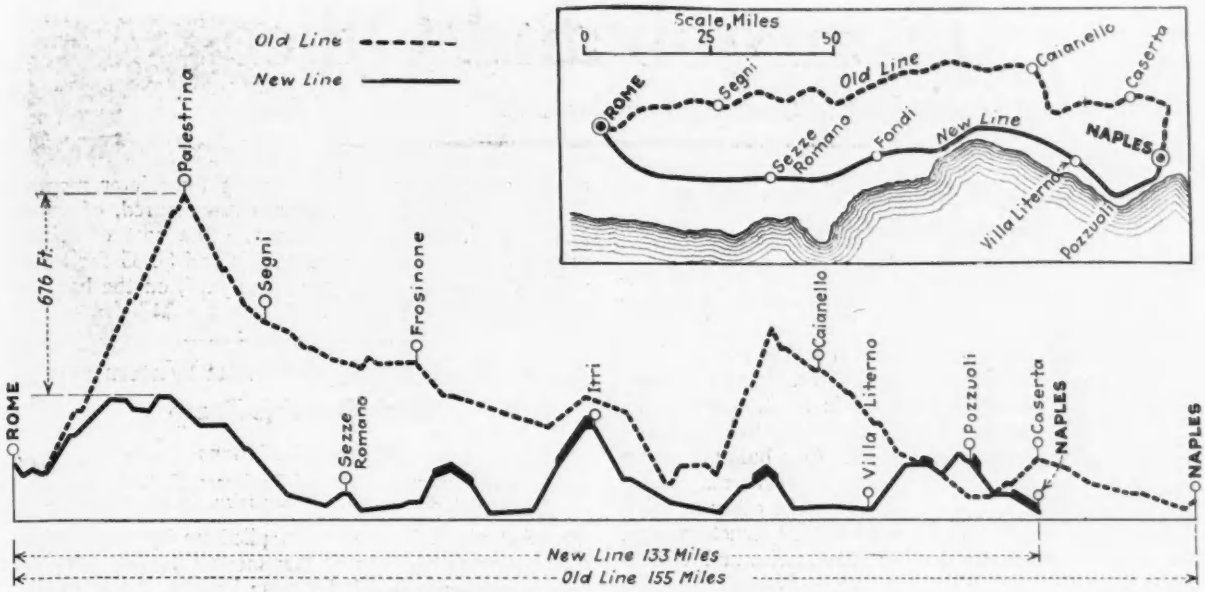


FIG. 2—NEW AND OLD LINES BETWEEN ROME AND NAPLES

way Gazette, London, but about 1888 a relocation between Rome and Segni shortened this by 15 miles.

On the new line there are 108 miles of tangents, some of them 10 to 17 miles in length. The sharpest curves are 3½ deg. Six tunnels aggregate 10½ miles, of which the longest is the Monte Orso tunnel, 4.66 miles. There are numerous bridges and viaducts, examples of

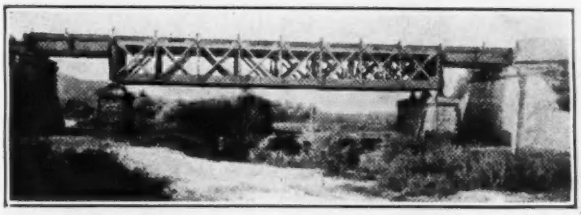


FIG. 3—STEEL TRUSS BRIDGE 73-FT. SPAN

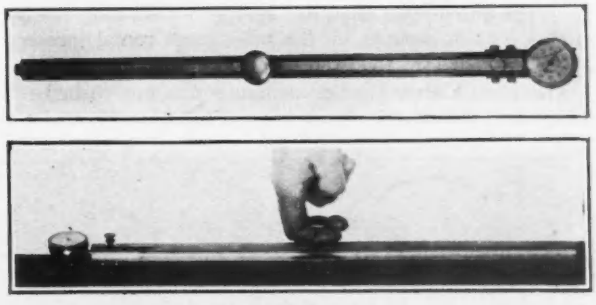
which are shown in Figs. 1 and 3. The line is double-track throughout, laid with T-rails 39.36 ft. long, weighing 96 lb. per yard on the open line and 100 lb. per yard in tunnels. There are 17 wood ties to each rail length, in 26 in. of crushed stone ballast. Automatic block signals are installed. Electric operation is in service from Naples to Villa Laterno and is being extended toward Rome.

While the actual shortening of distance is 22 miles, it is virtually equivalent to about 43 miles, owing to the easier grades and consequently higher speeds. Thus the time on the old line was 4½ hours, while on the new line it is 2¾ hours and will be still further reduced when electrification is completed. In addition to the more favorable location for high-speed service, the new line traverses fertile country having extensive industrial development, while the old line is in volcanic country and crosses many torrential streams which occasionally carry away bridges and fills and interrupt traffic completely.

Gage Measures Wear of Rails

TO MEASURE the batter of rail ends according to the recommendations of the rail committee of the American Railway Engineering Association, an instrument has been devised measuring to an accuracy of 0.001 in. This instrument, shown in the accompanying view, consists of a rigid straight-edge having an indicator point and automatic dial at one end. In use, the gage is set upon the railhead, with the dial toward the joint and about 6 in. from the end of the rail. The hand of the indicator is then set at the zero mark on the dial. The gage is shifted slowly along the railhead toward the joint, the point of the indicator then dropping into the depression formed by the wear or battering of the rail, the straight-edge representing the true or original surface of the head. Pointed attachments alongside the straight-edge are ½ in. beyond the indicator point, so that when these points are at the rail end, the dial indicates the depth of batter or vertical wear at ½ in. from the rail end, which is the desired position for measurement.

The large-headed screw on top of the straight-edge is at about the balancing point, so that with fingers in-



RAIL BATTER GAGE

serted under it, as shown, the gage can be lifted quickly and reversed for measuring the batter of the adjacent rail, thus giving the relative condition of the two rails at the joint. This instrument has been developed by H. H. Morgan, manager of the rail and fastenings department of the Robert W. Hunt Company, Chicago. A patent has been applied for, but in order to make the instrument available at a minimum cost, arrangements have been made with the Humboldt Manufacturing Company, Chicago, to produce and put it on the market at a specified price.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

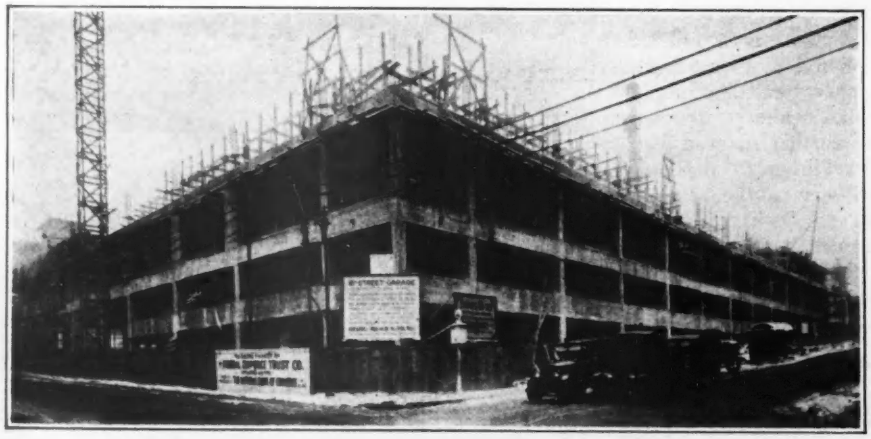
Unit Costs of Winter Concreting on Two St. Louis Buildings

THE following cubic-yard costs of heating and protecting concrete in constructing two similar buildings simultaneously in the winter of 1924-25 indicate the variableness of this expense, which makes every winter construction operation an individual problem in estimating. Both buildings were erected in St. Louis, Mo., by the same contractor, the Fruin-Colnon Contracting Company, which give the figures cited. One building was a four-story garage a block square; the concrete framework is indicated in the illustration. The other building was a market building of almost identical structure type, also a block square and having four stories and a basement.

The garage building was begun on Labor Day, 1924, and was turned over to the owner on Feb. 1, 1925. The illustration shows the work on Jan. 2. The concrete materials were heated in bins with steam coils, and the water was heated by steam coils running through the tanks. The concrete entered the forms regularly at 70 deg. when the outside temperature was 10 to 20 deg., and concrete was placed even when the temperature was about zero. The records show that, for the 6,900 cu.yd. of concrete on this work, the cost of coal, piping and labor to heat the concrete in bins was $0.30 per cubic yard. The cost of salamanders, coke and labor to heat the concrete after placement was $0.70 per cubic yard, and the cost of tarpaulins, lumber and labor to protect it was about $1.25 additional, making a total of about $2.25 per cubic yard.

The speed with which this job had to be completed, it is considered, probably accounted for this large unit cost of winter protection. The owner, however, was promptly compensated by the large rental he obtained from the automobile show by having his building ready at that date as well as by the subsequent rental income which immediately followed.

The New Union Market structure was not rushed to completion during the winter time, although a great deal of the concrete was poured during the winter months. There was 12,000 cu.yd. of concrete poured, of which 7,300 cu.yd. was superstructure. The cost of winter protection was $0.50 for materials and $0.85 for labor, making a total of $1.35 per cubic yard, on the basis of the 7,200 cu.yd. above ground.



GARAGE CONSTRUCTED IN WINTER AT ST. LOUIS, MO.

Wash Borings in Tidal Waters With Portable Pump

By John R. Noyes

First Lieutenant, Corps of Engineers, U. S. Army, Secretary, Alaska Road Commission, Juneau, Alaska

A BAR about 3 miles wide, piled up by tidal action, obstructs one end of Gastineau Channel, a waterway in southeastern Alaska, near Juneau. Most of this bar lies betwen 10 and 15 ft. above mean lower low water, and due to the large tidal range (maximum 26 ft.) no part of it is either permanently dry or submerged. For about three hours at each ordinary high water it presents much the appearance of an inland sea, being covered at highest tides more than 6 ft., and for about seven hours near each low water it is entirely uncovered. One can then walk upon it freely and can even drive across it in an automobile.

FIG. 1—MAKING WASH-BORINGS
At left—Jetting outfit with 5-ft. pipe; pipes as long as 20 ft. were used. At right—Putting down a jet hole in shallow water

It was desired to locate across the bar a dredged channel for small boats, which could be used at high tide by the large fishing and trading fleet operating out of Juneau, and to determine definitely by borings whether any rock or other hard material existed along this pro-

FIG. 2—TRANSPORTING PUMP OVERLAND

posed improvement. A shallow existing slough extending almost across the bar was easily determined to be the best and shortest route; therefore the problem resolved itself into taking borings to determine the nature of the bottom. It was necessary that equipment used on this work be inexpensive, light and easy to move.

A light pump of a type used in fighting forest fires was found suitable. This pump is direct-connected to a four-cylinder, two-cycle, high-speed gasoline motor. This equipment, capable of delivering about 40 g.p.m. at a pressure of 120 lb. per sq.in., weighed only about 80 lb. The discharge from the pump was connected through a hose to a 1-in. iron jetting pipe bearing a nozzle with ½- to ¾-in. orifice. It was soon found, however, that separate nozzles tended to break off at the point of attachment, and better results were obtained by having the end of the pipe itself drawn down to form a nozzle. The jetting work is shown in Fig. 1.

With the pump attached to a small sled of 2x6-in. timbers, it could easily be pulled over the mud, or be lifted and carried by two men, as shown in Fig. 2. A small skiff was usually kept at hand and when there was enough water the entire outfit was loaded into it and towed or rowed to the next setup. Three men could handle the entire outfit and assemble it for operation at each setup in about five minutes.

Work could be done at either high or low tide. As the pump and attachments were more easily handled on the sand bar than in a skiff, low tide was preferred, but work at low tide resulted in considerable wear on the bearings and runners of the pump from grit drawn into the suction pipe. Better results could probably be obtained in deeper water if the pump were mounted on a small flat boat with sufficient deck space for handling the pump and fittings.

In the soft glacial mud of which the greater part of the bar was composed it was possible to sink a hole 15 ft. deep in six or seven seconds, whereas in gravel or boulders it was found possible to penetrate 10 ft. in two or three minutes. The operation in gravel was mainly a matter of patience and working the jet point about, as the water soon washed away the finer material and the larger stones were overturned out of the way, permitting the point to slide past. It was found possible to penetrate patches composed of boulders up to 18 in. in diameter by working around them in this way.

More than 100 borings were taken in 6½ hours, including many short moves of equipment. In much of the area covered it was not necessary to take borings close together, so that moving the equipment took most of the time. There was always an exciting few minutes at the end of the day when the advancing flood tide made it necessary to suspend operations and get the equipment and men ashore. In 7½ working days 2 miles of channel was examined with this equipment to a depth of 2 ft. below mean lower low water, thus permitting an accurate determination of subsurface conditions across the entire bar.

Utah Now Using California Type Oiled Gravel Road

ON A relocation of the main highway east from Salt Lake City by the way of Parleys Canyon the California type of mulched oiled gravel is being tried. Three applications of ½ gal. each of 50-60 Utah asphalt are being applied to a gravel road. After each application the road is gone over with a disk harrow and spring tooth harrow drawn behind a caterpillar tractor. No rolling is done, but the asphalt and gravel is thoroughly mixed by a grader, which turns over the 3 in. of the top from 30 to 40 times. Finally the material is spread evenly and is compacted by the traffic. The road is graded for two weeks to make it compact evenly.

GRADER MIXES ASPHALTIC OIL WITH GRAVEL
Successive trips throws material in ridges, then spreads it.

Equation for Predicting Strength of Concrete

By F. N. Wray

Engineer of Special Assignments, Missouri State Highway Commission, Jefferson City, Mo.

THE equation given here for predicting the strength of concrete was developed from data published by the Portland Cement Association and based on the compression tests of 6x12-in. cylinders. The test specimens were made of several different mixes and water-cement ratios and were cured in a moist room and tested wet at ages ranging from seven days to five years. The equation in its several forms follows:

$$S_a = S_{28} - [(S_{28} + 2{,}000) \div 3] \ (1.447 - \log a) \qquad (1)$$

in which S equals the compressive strength in pounds per square inch, and the subscripts indicate the age of the concrete in days, a being any age (in days) between seven

days and five years. The log is the logarithm to the base 10. For convenience the equation may be transposed so that

$$S_{28} = (3S_a + 2{,}900 - 2{,}000 \log a) \div 1.553 + \log a \qquad (2)$$

But in case only the 7- and 28-day strengths are being considered the equation is simplified:

$$S_7 = 0.8S_{28} - 400 \qquad (3)$$

or

$$S_{28} = 1.25S_7 + 500 \qquad (4)$$

By comparing this last expression, which is only a special form of the general equation above, with Slater's equation, (*Proceedings*, American Concrete Institute, 1926, p. 437):

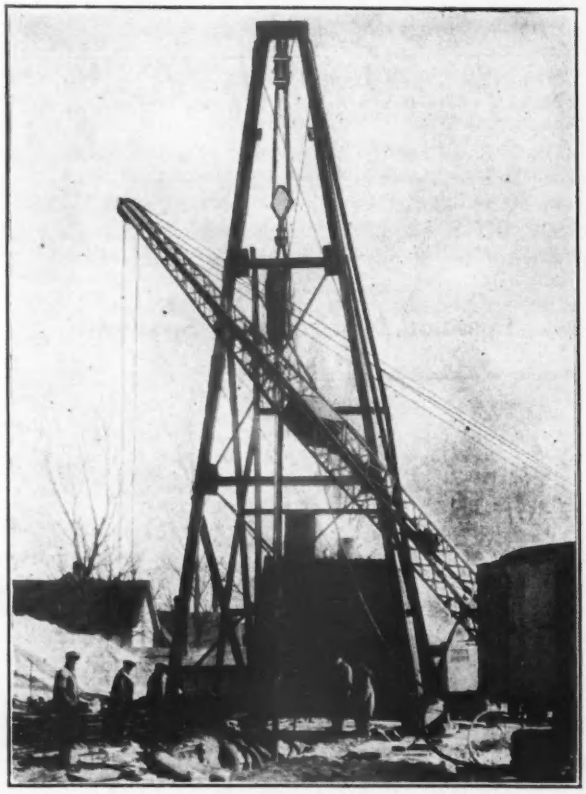
$$S_{28} = S_7 + 30\sqrt{S_7}$$

it will be found that the 28-day predicted strength by equation 4 will, as a rule, be a little lower than that calculated by the Slater equation.

Through the application of equations 1 and 2 it is possible to predict the strength of concrete at any age between seven days and five years when the strength at any other age between those same limits is given; however, unless the 28-day strength is known at the start, two separate calculations will be required. These equations are applicable regardless of whether S_a is greater or less than the 28-day strength.

Sheet Pile-Pulling Rig

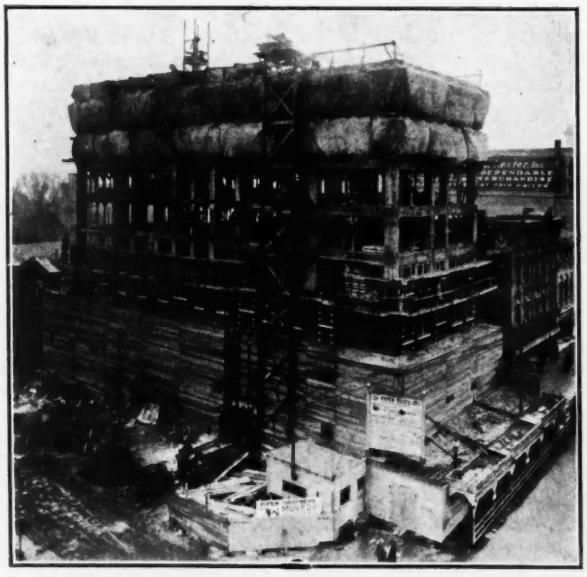
FOR pulling 34-ft. steel sheet piling from a sewer trench in stiff ground, where two inverted steam pile hammers were not powerful enough to do the work with sufficient speed, the contractor designed the outfit shown in the accompaning view and accomplished the work rapidly and economically. A steel tower 52 ft. high carries lifting tackle rigged through a pair of five-sheave blocks, the cable leading to a hoisting engine with 40-hp. boiler mounted in the base of the tower. The entire outfit travels on rollers on plank runways at the sides of the trench. With an inverted steam pile hammer hung from the lower block and with the engine putting a strain on the hoisting cable, a lifting force of about 55 tons was exerted on the pile to which the hammer was hooked. This pile-pulling rig was used by the J. J. Dunnegan Construction Company, Shenandoah, Iowa, on the Elwood Ave. section of the new northwest trunk sewer at South Bend, Ind. H. G. Wray is city engineer.



PULLING PILES WITH HAMMER AND HOIST

Unusual Inclosure for Winter Building Construction

THE two types of housing illustrated were used by Piper Bros. in constructing the Belmont Hotel at Madison, Wis., in the winter of 1927-28. The building was eleven stories, with a reinforced-concrete frame and brick exterior walls. The concrete aggregates were brought in by trucks and dumped through a hole in the sidewalk onto steam coils on the concrete floor of the basement, where the concrete was mixed hot. All floors from the ground up were concreted in canvas inclosures moved up as the work progressed. It took about eight hours to pour a floor and two stories were kept curtained constantly. The canvas inclosure was heated by coke salamanders. After the lower stories were concreted, the wooden housing shown was constructed to protect the stone cutting and interior finishing operations. The wooden housing was built to give a clearance of 8 ft. outside the walls. Concreting began late in the fall and the roof was poured in the following February. The temperatures ranged from a little above freezing to 30 deg. below zero. On the coldest night the face of one beam was frosted a little, but there was no real freezing. The general contractor was the Henry W. Horst Company, of Rock Island, Ill.



BOARD AND CANVAS HOUSING COMBINED ON WINTER BUILDING OPERATION

News of the Week

St. Francis Damage Claims Being Settled Speedily Out of Court

Expected That Claimants Will Be Recompensed at the Rate of $250,000 a Week

IN ADDITION to the expenditure of about $1,500,000 for rehabilitation work in the wake of the flood caused by the collapse of the St. Francis dam, near Los Angeles, on March 13, 1928, good progress has been made in the organization developed to review, appraise and pay claims for death, personal injury and property damage.

In this work the two committees of seven representing the city of Los Angeles and Ventura County, respectively, as noted in *Engineering News-Record* May 10, 1928, p. 732, have continued to function, having been divided into subcommittees for more effectively handling damage claims of various classes. While these committees refer findings to the Los Angeles City Council and to the Ventura County Supervisors, respectively, thus far this has been merely formal procedure followed by the prompt approval of committee decisions.

The investigation of claims for death, personal injury and property damage has only recently gotten fully under way, the first group of warrants being drawn July 18. It is expected that from now on these claims can be paid off at the rate of $250,000 per week until all have been settled. No recent estimates on total damage claims have been given out by city authorities but earlier estimates put the total at somewhere between $5,000,000 and $10,000,000.

The system under which the two committees are reviewing the claims is as follows: Written statements of the amount and nature of each claim are first examined by each of the two committees of seven sitting separately. When a number of claims have been thus reviewed the committees meet jointly and come to an agreement as to the amount of each claim. Claimants are then invited to appear before the joint session and any discrepany between claim and award is gone over with every consideration for the claimant's viewpoint. In this way, and judged from success thus far, it is believed that at least 95 per cent of the claims against the city can be settled out of court.

The financial plan for payment of awarded claims has been arranged to involve neither delay for claimant nor idleness of city funds set aside to await the issue of warrants as the investigation progresses. This is accomplished by arranging with local banks to pay claimants in full whenever they present warrants. These warrants the banks then turn in to the city council, where they are held until their total represents a considerable sum. The council then votes bonds (as it may under the California law for the payment of damage claims) for the actual amount necessary to meet the indebtedness. Thus no funds are made available until after the claimants have actually received their money and then the public funds are drawn upon only in the amount of the claims actually paid.

Denver Bond Sale Cancelled

Because of the low prices prevailing for municipal bonds, all bids for a proposed issue of $13,924,000 by the city of Denver, Colo., were refused and the sale was deferred to a later date. All of the bids were for less than the par value of the bonds.

River Straightening in Chicago to Proceed at Once

Award of the contract on Aug. 18 to the Great Lakes Dredge & Dock Company for straightening the south branch of the Chicago River marks the beginning of a series of improvements which will open the central business district of Chicago to the south with three new streets. The project was described in *Engineering News-Record*, Nov. 4, 1826, pp. 745-747.

The successful bidder was the second lowest bidder, the city asking first the Chicago Plan Commission and then the Western Society of Engineers to recommend to whom the award should be made. The latter submitted a list of engineers from whom the commission of public works picked the following: Joshua D'Esposito, Major Rufus W. Putnam, A. J. Hammond, L. F. Harza and W. W. De Berard. This committee reported that the low bidder did not have adequate equipment adapted to this class of work nor sufficient reserve equipment to meet the emergency demands which a large project of this character usually involves.

The bid of the successful contractor was $2,773,930 and that of the low bidder $2,569,043. The former figure is $600,000 less than original estimates made for the job. Previous bids were received on Feb. 6, but award could not be made because the Interstate Commerce Commission had not yet approved all transfers of railroad properties affected.

Federal Hearing on Kentucky Water-Power Groups Many Projects

Final Aim Complete Development—Navigation, Flood Control and Parks Considered

NINE applications for water-power projects, four of which require definite action in the near future, are before the Federal Power Commission at the present time. All have been filed by the Kentucky Utilities Company or by subsidiary companies, and are located on the Kentucky and Cumberland rivers in Kentucky and Tennessee. Inasmuch as these applications cover practically all sites on the two rivers in question capable of profitable development at the present time, the commission has deemed it advisable, before taking definite action on any one of them, to have a comprehensive study of the rivers made in order to determine the best system of development from the standpoint of power production and demand, navigation requirements and the public welfare in general. Such a study has been completed, and its results are embodied in a report soon to be presented to the commission. Although the separate applications are independent of one another, it is the intention of the commission to group them together, acting on each after full consideration of its effect upon the plan of development.

Applications for eleven other projects, besides the nine under present consideration, have been filed at one time or another and are being considered in the report. The twenty projects involve a probable installation of from 250,000 to 425,000 kw. and an estimated annual output of from 1,700 million to 2,000 million kw.-hr. Of the twenty sites fourteen involve power development at existing government dams, three the erection of new dams as part of the government plan of navigation development and three the construction of high storage dams above the sections hitherto included in navigation plans. The total output of the entire power system is far in excess of present power requirements; therefore a step-by-step development is indicated. The report, after detailed consideration of the merits and drawbacks of each project, sets up a proposed order of development which is deemed the most efficient from all points of view.

The two major projects from the standpoint of size are both on the Cumberland River; one at Cumberland Falls and the other at Wolf Creek. The first proposes an 80-ft. dam, a 4,800-ft. tunnel and a power house with an installa-

tion of 30,000 kw. and an average annual output of approximately 150,000,000 kw.-hr. Considerable objection has developed to this plant because of fear that the beauty of Cumberland Falls, a well-known scenic feature, will be destroyed. The report recommends that steps be taken to preserve the falls from injury by maintaining a minimum water flow.

The plans for the Wolf Creek site include a dam 170 ft. high backing water from 40 to 45 miles. The expense of locks, navigation facilities and land required have caused the report to place this project among the last to be constructed. The initial installation of 100,000 kw., with an ultimate enlargement to 180,000 kw., makes it advisable to wait until the rate of annual load increase on the system of the company is considerably greater than at present.

The report is being made public prior to presentation to the commission in order to give opportunity for the submission of requests for modifications. It will be presented to the commission about Sept. 13, after which it is expected that public hearings will be held before final action is taken.

Two Airports to Be Constructed in Middle West

Recent bond elections have insured the construction of modern airports for the cities of St. Louis and Kansas City, Mo. In both cases the proposals were approved by large majorities. The St. Louis field will cost about $2,000,000, will include 693 acres and will be provided with concrete runways for the largest types of airplanes, a central terminal building for passengers, mail and express, and modern lighting equipment. The runways will be 4,500 ft. long and 200 ft. wide. The field will be an enlargement of the old privately owned Lambert-St. Louis field.

The Kansas City airport will be located directly across the river from the city and will be reached by the Hannibal Bridge. The costs of necessary improvements will be about $1,000,000.

Railways to Study Union Freight Terminal Plans

The Port of New York Authority has announced that a contact committee, consisting of one or more representatives from each of the railways entering the New York district, has been named by the railroads to co-operate with the Port Authority in studying the proposed plan of establishing union freight terminals throughout the city. It is expected that an experimental station will be put into operation somewhere in Manhattan in the near future to determine the merits of the plan.

Kansas Assessment of Missouri Water-Works Upheld

Levy of a special assessment for drainage benefits upon water-works property of Kansas City, Mo., which is situated in the State of Kansas was upheld in a recent decision of the District Court of Kansas, despite the provisions of a state treaty which exempted the property from general taxation. The suit was brought by the Fairfax Drainage District of Wyandotte County, Kansas, a body created by the State of Kansas to protect from overflow certain property within which is located the Kansas City, Mo., water-works. The drainage expenses were assessed in proportion to the benefits received, but the city of Kansas City refused to pay its assessment, on the grounds that the treaty exempted it from the levy. This treaty, entered into by the states of Kansas and Missouri, provided that:

> Neither the State of Kansas, nor any county, township or municipality located within the state, nor any official thereof shall ever assess, levy or collect any taxes, assessments or imposts of any kind or character whatsoever on the portion of the water-works plant of the mnuicipality of Kansas City, Mo., now or hereafter located within the territory of the State of Kansas.

A similar measure was enacted by Missouri exempting the water-works of Kansas City, Kan., from taxation by Missouri.

In its decision the court held that the provisions of the treaty did not apply to special assessments; that it was the intention of the treaty to grant to the property of the respective cities such exemptions as they would have enjoyed if the state line had not separated them from their respective water-works, but that it could not be extended to include assessments to which they would have been subject had the state line not intervened.

Automatic Train Stops Finished on N.Y.C. Main Line

The New York Central has completed the installation of automatic train control apparatus on the entire length of its main line between Chicago and Harmon, N. Y., where steam operation changes to electric. This installation the longest in operation in the world to date, totaling 1,682.13 miles of line and 4,766 miles of track. The cost of the installation has been $4,631,000.

Am.Soc.C.E. Fall Meeting at San Diego, California

The fall meeting of the American Society of Civil Engineers will be held in San Diego, Calif., Oct. 3-5. The two days preceding, as usual, will be devoted to executive meetings. Papers of general interest to all members will be read on the first day, and the second day will be devoted to the sessions of the various technical divisions. The papers at this meeting will center about aviation, the subjects including the layout of landing fields, marking of airways and air routes, weather in its effect on air transport, passenger and express air service, etc.

The entertainment program offers attractive alternatives in inspection trips to any one of several notable dams, to the Imperial Valley, Salton Sea and Colorado River, also boat trips to the marine base or on deep sea fishing excursions. A major feature of the entertainment program on the third day of the convention is an excursion to the aviation field on North Island, where there will be "inspection of station and flights for all who wish to fly. Duration of flight, one to two hours. Maps will be supplied in order that objects may be identified. Ladies invited."

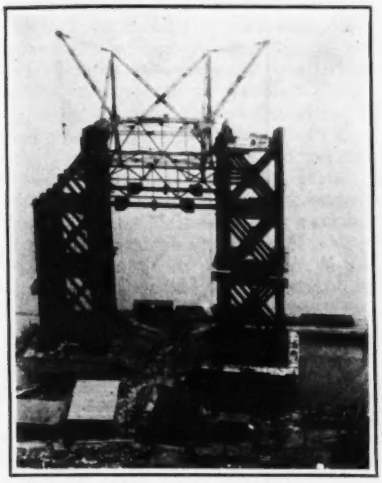
Russian Delegates to Study U. S. Water-Supply Practice

Three members of the Moscow, Russia, water-supply service are visiting the United States to inspect the water-supply systems of the larger American cities, with a view to adopting our ideas in the proposed extension of the Moscow system. This is to be enlarged from a capacity of 50 m.g.d. per day to meet an ultimate demand of 150 m.g.d. by 1950. In order to secure the necessary supply it will probably be necessary to draw water from the Volga River or the Oka River, a distance of about 75 miles.

MAINTAINING CONSTRUCTION FORCES IN THE DESERT

The construction of a power line across the plains of Texas by the Texas Power & Light Company involved unusual difficulties in boarding and lodging the men because of the difficulties of transportation through the heavy sand. The picture shows a typical base camp in which 200 men lived for 26 days. In hauling food to the advance gangs, caterpillar tractors hauling sled drags were sometimes the only means of transportation.

STEEL WORK ON HUDSON RIVER BRIDGE TOWERS PROGRESSING RAPIDLY



Steel erection on the towers of the Hudson River suspension bridge is progressing rapidly. The accompanying illustration shows the New Jersey tower erected to a level 150 ft. above the pier, about one-fourth of its ultimate height of 582 ft. Some idea of the size of the tower may be gained by comparison in the illustration with the freight cars on the barge anchored to the pier. On the New York side the vertical traveler has been completed, the huge shoes placed and the tower erection is well under way. The McClintic-Marshall Company has the contract for the furnishing and the erection of the steelwork.

Robert R. Jones Retires

Robert Ralston Jones, chief assistant engineer of the Cincinnati District, U. S. Engineer Corps, retired Aug. 20 after 45 years of continuous service on the Ohio, Mississippi and Kentucky rivers. When Mr. Jones was first assigned to the Cincinnati District, in 1892, there was only one dam on the Ohio River between Pittsburgh and Cairo, Ill.; now, with the completion of Dam No. 53 in 1929, almost 1,000 miles of river will be pooled for slack-water navigation. Besides playing an important part in the surveys and designs for development of the Ohio, Mr. Jones had direct supervision of the construction of fourteen locks and dams on the Kentucky River, all of which are now in operation.

Request Railway Extensions in South

The Birmingham, Selma & Mobile Railroad has filed an application with the Interstate Commerce Commission requesting permission to extend its main line a distance of 10 miles, and a branch line 22 miles, through Perry and Hale counties, Alabama. The proposed extensions will start from the present terminus at Jericho, Ala. The new lines will transport timber and pulpwood, agricultural products and fertilizer.

New York to Spend $75,985,000 for New Engineering Plant

An Elevated Highway and a Sewage-Disposal Plant Authorized—Sewage Board to Be Named

AT A BRIEF meeting of the Board of Estimate and Apportionment of New York City held on Aug. 15 expenditures totaling $75,985,000 were authorized for various public improvements. The projects include:

Sewage disposal plant, Wards Island	$37,000,000
Subway construction	20,000,000
Elevated express highway	10,000,000
Hospital building, Kings County	7,985,000
Sewers and paving, Queens County	1,000,000
	$75,985,000

The sewage-disposal plant is the first step in a plan to develop a complete disposal program for the city. It is planned to put all waste disposal under the jurisdiction of a sanitary commission of three members which will have complete jurisdiction over design, construction and operation of plants and sewers. Before this can be done authorization must be secured from the state legislature, and a bill is now being prepared for presentation to the next session. In the meantime, Borough President Miller of Manhattan was authorized to proceed with the preparation of plans for the Wards Island plant at a preliminary cost not to exceed $605,000.

Construction of the first section of the proposed elevated express highway from Canal St. to 72nd St. was also approved. This will extend from 59th to 72nd St. over the yards of the New York Central Railroad. Action on the remainder of the plan has been deferred until Sept. 27, pending the outcome of negotiations with the railroad company.

Bids Called on 20-Mile Water Tunnel at New York

The Board of Water Supply at New York is calling for bids upon City Tunnel No. 2, a deep water supply tunnel, extending from Hill View Reservoir in Yonkers, under the Bronx River and the East River at Rikers Island to the Borough of Queens on Long Island, thence under Newtown Creek to a connection with City Tunnel No. 1 in Brooklyn and thence about 1.3 miles to Hamilton Ave. in Brooklyn. The tunnel is to be driven from nineteen shafts of depths varying from 380 to 780 ft. The deepest shafts will be in the portion north of the East River. The East River crossing will be at depths varying from 560 to 615 ft. The finished diameter of the greater portion of the tunnel will be 17 ft.; the maximum diameter will be 21 ft. and the minimum 15 ft. A map showing the location of this tunnel was given in *Engineering News-Record*, March 31, 1927, p. 523. The total cost is estimated at about $67,000,000.

Storms Do Heavy Damage in Southeastern States

Much damage has been done the Southeastern states during the past two weeks by the tropical storm which crossed Florida into Georgia and Alabama and then turned east across North and South Carolina, reaching into Virginia and Maryland. Highways and railways suffered from numerous washouts and many small bridges were damaged or washed out. Several cities were isolated for days. Only one large dam is reported to have been endangered—the Lake Lure dam in North Carolina. Details of the extent of the damage to the structure are not yet available but we have been advised that part of the embankment sloughed off.

Fuertes Medal Awarded

The Fuertes Graduate Medal for 1928 has been awarded by Cornell University to Victor M. Ehlers and Ernest W. Steel for their book "Municipal and Rural Sanitation." The medal, established by the late Prof. E. A. Fuertes, a former director of the School of Civil Engineering at Cornell, is awarded annually to a graduate (or graduates) of the school who has written a meritorious paper on some engineering subject tending to advance the scientific or practical interests of the profession of civil engineering. "Municipal and Rural Sanitation" was reviewed in *Engineering News-Record* Dec. 15, 1927, p. 969.

WESTERN UNION TO BUILD IN NEW YORK

This new 24-story building will house the operating activities of the Western Union Telegraph Company in downtown New York. It will occupy the entire block bounded by Hudson, Worth and Thomas Sts. and West Broadway, will have a total floor space of almost 1,000,000 sq.ft. and will cost, including land and equipment, about $13,500,000. Excavation for the foundation, which will be of the concrete pile type, is already under way. Voorhees, Gmelin & Walker are the architects and Marc Eidlitz & Son the builders.

Brief News

FOUR ADDITIONAL TRAFFIC LANES on Park Ave., New York City, will be provided by widening operations between 57th and 72nd Sts. to be started shortly. Reduction of the center parkway from 40 to 23 ft. in width and of the sidewalks from 22 to 15 ft. will permit the widening of the two roadways from 28 to 43 ft. The cost to the city is estimated at $550,000, and to the New York Central Railroad, which is immediately below the avenue, $162,000.

THE CITY OF QUEBEC will start construction work on a municipal airport within a short time. The site will be selected from four possible choices now under study. It is planned to have six runways, a weather bureau station and a number of modern hangars and auxiliary buildings. The airport will be illuminated by large searchlights for the convenience of night fliers.

PERMISSION TO ERECT 130-ft. buildings without setbacks in Washington, D. C., has finally been denied by the zoning commission of the city. The limits stay as before: 110 ft. without setbacks and 130 ft. with setbacks.

THE FOUNDATION EXCAVATION for the Hotel New Yorker in New York City has been completed. More than 2,250,000 cu.ft. of rock has been removed at a cost of about $1,000,000. The bottom of the completed excavation is 75 ft. below the curb.

DEEPENING OF THE SAGUENAY RIVER in Canada has been extended to the city of Chicoutimi, Que., where the water has a minimum depth of 16 ft. at low tide. The Canadian government is planning to spend approximately $3,000,000 in expanding the harbor facilities at Chicoutimi to provide for the constantly increasing traffic of that region.

A NEW CLASSIFICATION YARD of the Pennsylvania Railroad has been completed at Crestline, Ohio, to serve the Chicago district. The cost was approximately $2,000,000. The new yard will handle about 1,600 cars daily, using the gravity system.

NIGHT COURSES leading to the advanced degrees of Master of Civil, Mechanical or Electrical Engineering are to be offered this fall by the Polytechnic Institute of Brooklyn, N. Y.

A DETAILED SURVEY of the harbors in Lake Ontario district is to be made by the U. S. Corps of Engineers, under Major Thomas, district engineer at Buffalo, N. Y. The survey is being made in anticipation of the opening of the Welland Canal in 1930 to determine what shipping may use the harbors in the event upper lake shipping men decide to extend their operations to Lake Ontario and the St. Lawrence River.

RANDOM LINES

Not Forgetting Those Who Wrote

The following is clipped from the *Journal* of the Engineers Club of St. Louis:

> If all the people who have talked about the Mississippi River problem during recent months were laid end to end, it would be a great relief to the public.—*Col. Arthur C. Morgan.*

* * *

Microscopic Maps

A reporter for the New York *Times* puts the following words into the mouth of Col. E. Lester Jones, head of the U. S. Coast and Geodetic Survey, in an interview upon his return from the International Geographic Congress:

> The Colonel added that the most important thing accomplished by the Congress was the unanimous agreement of the delegates to a uniformity of measurement in drawing maps. In future they will be made on a scale of a millionth of an inch to the mile so that the public will be able to understand any map no matter in what country it may be published.

* * *

Engineers Rate With Ministers

Princeton men, according to recently compiled figures dignified with the name of statistics, show that Princeton graduates of nine years' standing earn (or are paid) average incomes of $6,200 per year. The amount would be higher but for the inevitable lame ducks. Read the reporter's words:

> The average is kept down by those in the teaching profession, the ministry, engineering and government service.

The ministry, engineering; or, as we used to say in the freshman year, *Quod crat demonstrandum.*

WASHINGTON NOTES

By PAUL WOOTON
Washington Correspondent

Flood-Control Sentiment Changes—Low Bids Cause Stir—Old Bidding Rule Amended

ADVICE from the lower Mississippi River to the Corps of Engineers indicates that the opposition to the army engineer plan, which recently was approved by the board appointed to review the flood-control plans, is not as great as was the case when the flood-control act was under discussion. The main factor contributing to this change of sentiment is the fact that the army engineer plan provides for a possible flood of 3,000,000 sec.-ft. The people of the lower valley would not like to see their protection limited to the volume of water produced by the 1927 flood. They have seen the Mississippi River Commission change the levee grade too often to have great faith in its predictions as to flood levels along the river.

There also is general concurrence in the proposal that the volume of water allowed to pass New Orleans in the main channel be limited to 1,250,000 sec.-ft. There is general agreement with the army engineers that the proposed spillway at Caernarvon, below New Orleans, would increase velocities, underwater scour and consequent dock and bank settlement.

There is intense local feeling in the Tensas and Atchafalaya basins against the fuse plug type of levee, but even in that case the arguments presented by the board against the controlled spillway seem to have had weight.

Representative Wilson, a member of the committee on flood control, takes exception to the finding of the board in which the sections of the bill pertaining to flowage and other damages are held to require legal interpretation. He thinks the act in those particulars is thoroughly clear and understandable. If by any chance the existing language should not be clear to the law officers to whom it is to be referred, he says, Congress will be ready at any time to make it very clear that "property taken for the benefit of the valley, or damage caused to protect the people elsewhere, is to be paid out of the flood-control appropriation."

M. R. C. Underbids Contractors

Although no awards have been made yet on the levee work in the New Orleans District, the estimates of the Corps of Engineers are low on 80 per cent of the new work, according to D. H. Sawyer, secretary of the Associated General Contractors. The bids, which were opened on Aug. 6, include work on 35 projects. Colonel Sawyer pointed out that the number of bids received gives ample assurance that there is plenty of competition.

Referring to the Mississippi River Commission's figures as surprisingly low, Colonel Sawyer expressed doubt that these estimates had been prepared with sufficient care. He mentioned one particular case involving the moving of 750,000 cu.yd. of earth in which the government's estimate was 19c. per cubic yard, while the nearest contractor's bid was 34c. The evidence in this case would show, he believes, that the government figures were calculated inaccurately, since there were many contractors bidding against one another on the project.

Representatives of the Associated General Contractors who were in the lower Mississippi Valley at the time the New Orleans and Memphis districts' bids were opened, claim that an item of 1½c. per yard for inspection was added to the contractor's bids.

Bid Revision Permitted

The well-established rule that the contractor must bear the consequences of a mistake in the submission of his bid is given an extension of meaning that somewhat lessens its severity by a recent decision of the Comptroller Gen-

eral. According to this decision, which involves the furnishing of hardware supplies for the Veterans' Bureau Hospital at Legion, Tex., the contractor is entitled to recovery if his mistake is obvious and as long as he will still be the low bidder when the extra amount is added.

In this particular case the contractor was bidding on a number of various sized pipe wrenches. In items covering the cost of a number of the larger sized wrenches he put down the digits but left off the dollar sign. Thus it was apparent, from the bid itself, that he was charging more for the smaller wrenches than for the larger. The Comptroller General, in awarding the contractor payment for the amount, points out that the contracting officer should have discovered the mistake and then should have asked the contractor to verify his bid.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.; Annual Convention, Montreal, Canada, Sept. 18-21.

NATIONAL SAFETY COUNCIL, Chicago; Annual Meeting, New York City, Oct. 1-5.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York, N. Y.; Fall Meeting, San Diego, Calif., Oct. 3-5.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.; Annual Convention, Detroit, Mich., Oct. 22-28.

THE NEW ENGLAND WATER WORKS ASSOCIATION has extended to all water works men an invitation to attend the 47th annual convention at Montreal, Canada, Sept. 18-21. The New York Section of the American Water Works Association has already planned to take advantage of this opportunity for a joint meeting, and individual members of other organizations are expected to be present. Hotel accommodations are in charge of J. Davidson, manager of the Windsor Hotel, Montreal. Victor E. Arnold, 50 Church St., New York City, is responsible for manufacturers' exhibits.

THE WEST VIRGINA ROAD BUILDERS' ASSOCIATION was organized on June 29 at Huntington, W. Va. The following were elected officers of the association: president, W. T. Coleman; vice-presidents, J. K. Monroe, W. J. McLaren, Harry McGraw, William James and Paul Blundon; treasurer, Julius J. Monroe; secretary, Howard A. Levering. The headquarters of the association are at Huntington, W. Va.

THE ENGINEERS' CLUB OF ST. LOUIS held a reception on Aug. 14 in honor of William S. Mitchell to commemorate his completion of 50 years of service in the engineer department at large of the U. S. War Department.

Personal Notes

ELWOOD MEAD, director of the U. S. Bureau of Irrigation, was the guest of honor at a luncheon given on Aug. 15 by the Chamber of Commerce of Casper, Wyo.

BERNARD L. CROZIER, former chief engineer of Baltimore, has been employed by the Board of Estimates, Baltimore, as designing and constructing engineer of a new bridge to be erected at Loch Raven to replace one that collapsed during a storm in June.

Lieut. E. B. KEATING, Civil Engineer Corps of the Navy, will shortly be detached from duty at the Newport, R. I., Naval Training Station and assigned to duty under the engineer in chief of the Republic of Haiti. This is in accord with the existing treaty which places a naval engineer in charge of all public works on the island. For carrying out this work, which includes the construction of roads and bridges as well as waterfront improvement, these engineers are allowed an expenditure of $3,000,000 a year.

C. M. LIGHTBURN, president of the Colorado Engineering Council and secretary of the Colorado Society of Engineers, has been selected to represent the engineers of Denver on the Denver Traffic Commission.

MARK D. FIENKNOPF, formerly associated with Leo Yassenoff in the F. & Y. Construction Company, Columbus, Ohio, heads a newly incorporated company known as the Mark D. Fienknopf Company, Inc., of Columbus, which will engage in general contracting and engineering business.

FREDERICK G. CLAPP announces that he has completed his engagement as petroleum engineer to the imperial government of Persia and will continue his consulting practice at 50 Church St., New York City.

CARL F. MEYER, formerly highway engineer of Hennepin County, Wisconsin, is now city engineer of Eau Claire, Wis.

FRANK M. TOWNSEND, formerly supervising engineer in El Salvador for the International Railways of Central America, is now employed as locating engineer with Kennedy & Carey on the Cochambata-Santa Cruz Railroad in Bolivia, South America.

D. B. LEVI, division engineer for the Missouri State Highway Department, with headquarters at St. Joseph, has been appointed construction engineer for the department. He succeeds Ray Dunlap, recently named city engineer of St. Joseph. J. J. Corbett, assistant engineer of surveys and plans for the highway department, will succeed Mr. Levi as division engineer.

O. E. NOBLE has recently been appointed city engineer of Lawton, Okla.

GEORGE B. AVERY, assistant supervisor of the State of Washington Department of Labor and Industries, has been appointed superintendent of public utilities of the city of Seattle.

E. A. WOOD, for the last year and a half city engineer of Dallas, Tex., has been appointed to the position of master planner for the city. He will be succeeded by John Young, assistant city engineer, as city engineer, and by F. L. Park as city plan manager.

G. E. WRIGHT has resigned as chief engineer and superintendent of the Trenor Land Company, New Rochelle, N. Y., where he has been directing a large real estate development for the last four years, and will join the organization of D. F. MacNamee & Company, Inc., contractors, of the same city, as construction superintendent and engineer. Mr. Wright was formerly assistant city engineer of Gloversville, N. Y., and assistant engineer on the city engineer's staff at Bridgeport, Conn.

HUGH J. SPEARING has been appointed superintendent of construction for the James Torrestal Company, of Beacon, N. Y., on the Mechanics Bank Building in Beacon. Mr. Spearing was formerly with Stone & Webster, Inc., of Boston, and other concerns engaged in the erection of public and private buildings.

A. M. TRUESDALE has been appointed chief assistant city engineer, in charge of bridge construction and design, for the city of Tacoma, Wash. He will have immediate charge of the proposed steel and concrete bridges to be constructed on the tideflats.

Obituary

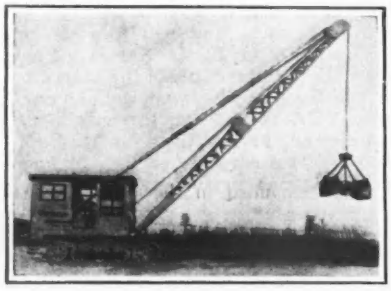
ALLEN M. SCHOEN, president of the National Fire Protection Association, died on Aug. 15. He had taken a prominent part in the activities of the association for many years, having served as a member of the executive committee and as vice-president before his election to the office of president for the current year. Mr. Schoen was the N.F.P.A. representative on the American Engineering Standards Committee.

GUSTAF A. CARLSON, head of the firm of Siems & Carlson, of Spokane, Wash., died on Aug. 8. He was born in Sweden on July 19, 1864, and went to the Pacific Coast in 1882, since which time he had made a notable record as railroad builder and general contractor, his firm being engaged at the present time on work in Idaho, Washington and Alaska totaling over $1,000,000. Mr. Carlson was past president of the Spokane chapter, Associated General Contractors.

Construction Equipment and Materials

New Crawler Type Crane

A gas- or electric-operated full-circle crawler crane is now being manufactured in ½-, ¾-, and 1-yd. sizes by the H. D. Conkey Company, of Mendota, Ill. Advantages claimed for this unit are low center of gravity, ease and speed of operation, rugged construction, low power loss, absence of friction clutches and low maintenance cost. An exclusive feature of the machine is the



method of engaging hoisting and holding drums. A heavy ball thrust bearing, together with a special thrust nut, provides an effective means of operation and eliminates all thrust screws, washers, springs and cams. Lubrication is by oil cups and the Alemite system. The traveling gear is arranged for two speeds under control of the operator regardless of the position of the turntable. The crane is self-contained, full-circle, and is equipped with endless tread traction. It may be used with grab or drag-line bucket, or with a hook block, all operations being controlled by one man.

Power Take-Off on Grader Permits Its Use in Shifting Sand

In cutting a street through a sand dune and filling in another stretch about half a mile away in Gary, Ind., William Hillmer, contractor, used an elevating grader with power take-off and a 7-yd. crawler dump wagon, both hauled by caterpillar tractors. According to the Austin-Western Road Machinery Company, Chicago, whose equipment was used, the power take-off on the elevating grader was the key to the problem. Had the elevator been driven through the rear wheels, it is said, the work could not have been accomplished, since the wheels would not have had sufficient traction in the sand. With the power take-off, the elevator is driven directly from the tractor engine. The crawler equipment on the unit also contributed notably to the success of the work.

New Testing Sieve Eliminates Square Corners

A new testing sieve equipped with an improved joint has recently been developed by the Newark Wire Cloth Company, Newark, N. J. An important advantage of this new sieve is that the inside corner is rounded instead of sharp. A sharp inside corner in a sieve always gives trouble by filling up with material, making it hard to keep clean. It also interferes with accuracy and quick work. With round corners these troubles are said to be avoided. Another improvement is that all soldering is done on the outside and not on the inside. When the wire cloth becomes so worn as to need replacing with a new piece it can readily be done by melting the old solder off and then soldering the new piece of cloth on. This is all accomplished without distorting the cloth.

The Newark sieves are made in 3, 5, 6, 8, 10 and 12 in. diameters and in accordance with U. S. Bureau of Standards specifications, adopted as standard by the American Society for Testing Materials in 1926.

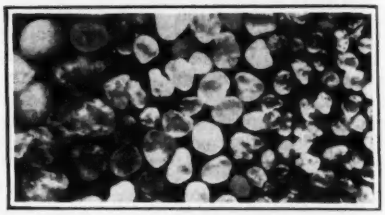
New Protective Coating for Structural Steel

Perfection of a new process of manufacturing asphalt paint has been announced by the paint and varnish division of E. I. du Pont de Nemours & Company, Wilmington, Del. The new product is described as asphalt chromate emulsion. This emulsion is intended as a protective coating for structural steel, underground and other pipe lines, special marine and railroad purposes and for a wide range of industrial uses. The material is applied cold by spraying or with a brush upon either dry or wet surfaces. The new product differs from other asphalt paints in that no solvents or cut-back ingredients are required, thus making the emulsion safe for use in confined spaces. It gives off no inflammable vapors or toxic fumes, while all of the desirable properties of pure asphalt are claimed to be retained.

In the making of asphalt chromate emulsion, asphalt is combined with water in the process of emulsifying. Chromium salts are added, thereby making ferrous metal passive to corrosion while the water content of the paint dries, this requiring about seven or eight hours.

Filter Flints Closely Graded

A deposit of flint sand now being developed by George F. Pettinos, 1206 Locust St., Philadelphia, Pa., yields round grains of pure flint of unusual hardness. Many sizes are available, so that the flints can be supplied to meet

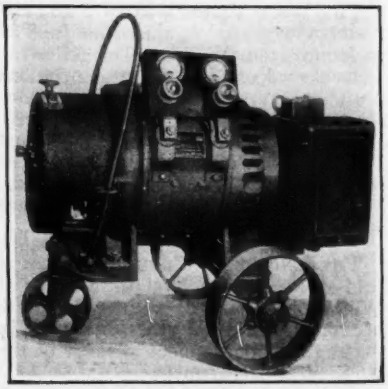


practically any specifications. The illustration shows the close grading secured and the way in which the size of the particles can be gradually changed in the filter bed. The grains as shown are magnified about five diameters. In developing the deposit, great care has been taken to insure uniform, accurate grading and careful cleaning of the sand.

New Arc Welder Features Simplicity of Design

A new portable arc welder is offered in several capacities by the Fusion Welding Corporation, Chicago, Ill. The machine is light and compact and therefore easily portable. The design is such as to require no exciter, no external stabilizer for the arc and no rheostat. Unusual arc flexibility is claimed. In the electric drive models there are available a 200-amp., a 300-amp. and a 400-amp. machine, while in the gas-engine drive design 200-amp. and 300-amp. models are offered. The electric motor drive machines are available for any line current supply.

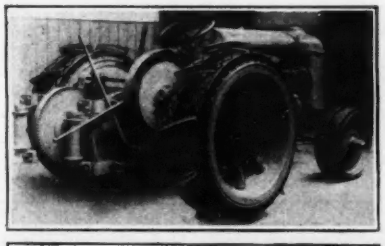
All welding equipment requires an electric generator to compensate for the natural lack of arc stability. On some machines so-called external stabilizers are incorporated in the generator outfit, while on the Fuzon generator, sta-

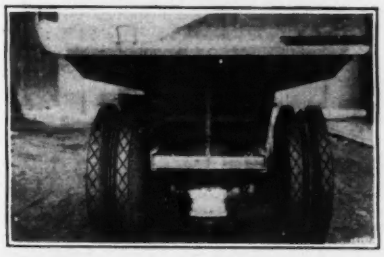


bility is secured by a special design in the winding of the generator itself. It is claimed that by this means the commutating windings act also as stabilizer windings. It is claimed that it is practically impossible to change the length of the arc so quickly that it goes out and further that it can be instantly changed in length when required. No external means of excitation is required, this being supplied from the same brushes from which the welding current is drawn. Thus the excitation current varies with the welding current, a characteristic which is claimed to be equivalent to automatic control. All rheostat switches and similar auxiliary apparatus are eliminated on this new welder. The current output of the generator is regulated by shifting the brushes. It is claimed that the greatest advantage of brush-shifting current control lies in the fact that uniform arc flexibility is maintained over the entire range of output of the machine. The welder can be used not only for metallic arc welding but also for carbon arc welding and cutting.

New Rubber-Tired Tractor Wheel Incorporates Disappearing Lugs

In the accompanying illustration is shown a dual rubber-tired tractor wheel into which a new demountable type of lug is incorporated. When the lugs are not required, it is necessary only to





lift them up 2 in., turn them parallel with the wheel, let go and they disappear between the dual tires or into the space left between the dual tires for the purpose of applying these lugs.

The wheel is an English invention, developed in Manchester, England, by the Muir Hill Company four years ago and is said to have been sold there in large quantities both to industrial users and to the English government for use on heavy-duty trucks and tractors. Exclusive license for its manufacture and sale in the United States is held by the Wehr Company, Milwaukee.

Business Notes

LINK-BELT COMPANY, Chicago, Ill., announces the appointment of two Pacific Coast representatives. Garfield & Company, San Francisco, Calif., are now agents for northern California and Nevada for the entire Link-Belt line of shovels, drag-lines and cranes. R. B. Randall has been appointed manager of the Pacific Coast division for the crane and shovel department of the company.

UNIVERSAL CRANE COMPANY, Cleveland, Ohio, announces that, effective immediately, its general sales and advertising offices are moved to 28th and Fulton Sts., Lorain, Ohio.

A MERGER of concrete machinery manufacturers in the Middle West has recently been effected. The companies concerned are the Anchor Concrete Machinery Company, Columbus, Ohio; Ideal Concrete Machinery Company, Cincinnati, Ohio; Universal Machine Company, Peoria, Ill.; and the Consolidated Concrete Machinery Company, Adrian, Mich. Headquarters will be established in Adrian, Mich. G. M. Friel, formerly of the Anchor Concrete Machinery Company, has been appointed district manager of the Columbus territory.

Manufacturers and Trade Associations

CALENDAR

ANNUAL MEETINGS

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

CONCRETE REINFORCING STEEL INSTITUTE, Chicago; semi-annual meeting, Buckwood Inn, Shawnee-on-Delaware, Pa., October 1-3, 1928.

New Publications

Power Shovels—SPEEDER MACHINERY CORPORATION, Cedar Rapids, Iowa, has published a new 16-page catalog illustrating and describing its new B-2 shovel. Working diagrams are given of the machine fitted to act as a shovel, a crane or a skimmer scoop. Illustrations and descriptions of the important mechanical details of the equipment are included.

Steel Tanks—CHICAGO BRIDGE & IRON WORKS, Chicago, Ill., has published a booklet entitled "Gravity Water Supply" which describes the use of steel tanks in providing gravity pressure for private and municipal water-works systems. Many illustrations are given of the company's large-size tanks, ranging from the 2,000,000-gal. size down. Pumping and distribution pressure charts before and after installing elevated tanks in some of the cities are included. In addition, the book contains a number of tables with regard to the installation and operation of gravity water-works systems.

Highway Guard Rails—RAMSEY SAFETY GUARD RAIL COMPANY, 11 North Pearl St., Albany, N. Y., has made available a folder describing its patented guard rail, which consists of malleable iron supports so designed as to absorb the forces of impact and of double cables between the supports carried by pivoted equalizer arms. The booklet illustrates installations made on several New York state highways, and in addition gives estimated costs and other pertinent data.

Concrete Floors—MASTER BUILDERS COMPANY, Cleveland, has published a 28-p. booklet entitled "Plain Talk About Concrete Floors," which is the result of a survey of concrete floor conditions in industrial plants. The book reviews the principal methods that have been used to produce floors that will stand up under industrial traffic. Many illustrations are given of floors which have failed, as well as of good floors. There is also included in the book a discussion of the use of surface treatments, integral liquid hardeners and metallic hardeners, all of which are manufactured by the Master Builders Company. The results of abrasion tests on concrete made at Ohio State University are given in the booklet.

Engineering Achievements—A. O. SMITH CORPORATION, Milwaukee, Wis., has published a booklet entitled "Four Hundred Engineers and Eight Salesmen," which deals primarily with the engineering achievements of the company in the production of electric-welded gas-line pipe, automobile frames, pressure vessels and couplings. The automatic frame plant, which is an important contribution to the automobile industry, is extensively reviewed in the booklet.

Tunnel Construction Ventilation—E. I. DU PONT DE NEMOURS & COMPANY, Wilmington, Del., devote a new 14-p. catalog to the use of their flexible tubing, Ventube, as it is called, for carrying good air to the working faces in underground operations. Many illustrations are given of operations in connection with the New York subway work where ventilation is necessary. Illustrations are also given of various tubing fittings and accessories necessary.

Vibrated Concrete Pavement—AMERICAN VIBROLITHIC CORPORATION, Des Moines, Iowa, has published a new booklet entitled "Armorplated Compressed Concrete Pavement," which tells the story in pictures of the construction of vibrolithic pavement on Sheridan Road in Chicago.

Steel Windows—DAVID LUPTON'S SONS COMPANY, Philadelphia, Pa., describes four types of Lupton steel windows, made in 50 sizes, in a new catalog. The windows are suitable for office buildings, hotels, apartment houses, hospitals and other high-grade buildings.

The Business Side of Construction

Contract Letting Continues to Break Previous Records

Value of Construction Projects 16 Per Cent Over Last Year in First Seven Months

TO SAY that construction is normal these days is to say that records continue to be broken. The value of contracts awarded during the first seven months of this year was 16 per cent greater than the value of those awarded in the corresponding months of 1927. For the first seven months of 1928 the total exceeded two billion dollars—a record. Moreover, this activity is confined to no single region of the country, but is recorded generally. Not only this; the activity is in all the major classes of construction. The following discussions will concern heavy construction work in the field of engineering construction, which excludes small jobs, repair work and dwelling construction.

CONTRACTS—JAN. 1 TO AUG. 1
(By Sections)

	1928	1927	Per Cent Change
New England	$138,818,000	$142,079,000	—2.1
Middle Atlantic	766,994,000	541,210,000	+41.6
South	140,301,000	125,461,000	+11.7
Mid-West	499,889,000	422,835,000	+18.0
West of Miss.	296,039,000	310,784,000	+ 4.7
Far West	188,010,000	213,260,000	—11.3
United States	$2,030,051,000	$1,755,629,000	+15.7
Canada	91,555,000	63,188,000	+44.8

This year's figures are ahead of last year's for private work, while public contract lettings during the first seven months were about 7 per cent less than those of last year. Industrial buildings or plant expansion is 12 per cent ahead of last year's mark, while commercial building tops 1927 by 31 per cent. This is a significant item, as it indicates confidence on the part of business leaders in a continuance of high productive programs.

Roadbuilding is perhaps the most constant and dependable element in construction volume. There have never been wide fluctuations from year to year; yet this year's value is $375,226,000, compared with $282,209,000 last year, which is 33 per cent more.

The most conclusive illustration of the wide geographic participation in contract letting is to be found in the figures themselves. The table gives the figures for this year and last year for six great regions of the United States and Canada.

The contracts let during the week ended Aug. 14 indicate that the current fall volume of construction will also be larger than that of last year. During that week contracts let totaled $64,997,000, against $54,977,000 for the same week last year, a gain of about 18 per cent. The greatest increases over last year are in sewers and commercial buildings, which recorded a gain of 42 per cent and 58 per cent respectively. Streets and roads recorded a drop of 42 per cent from the same week last year.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended Aug. 21, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
Aug. 21, 1928	$28,611	$60,582	$89,193
Aug. 14, 1928	25,473	39,524	64,997
Aug. 26, 1927	27,721	39,268	66,989
Jan. 1 to Aug. 21:			
1928	878,538	1,460,035	2,338,573
1927	820,323	1,224,650	2,044,973

E. N.-R. Index Numbers

Cost			Volume		
Aug. 1,	1928	207.29	July,	1928	266
July 1,	1928	206.65	June,	1928	308
Aug. 1,	1927	205.50	July,	1927	252
Average,	1927	206.24	Average,	1927	263
Average,	1926	208.03	Average,	1926	228
1913		100.00	1913		100

General Manufacturing at New High Levels

Monthly reports received by the *Electrical World* on the consumption of electrical energy by about 3,000 large manufacturing plants scattered throughout the nation indicate that American industry, taken as a whole, is operating at a rate materially above that which past history would indicate for this season of the year. The rate of general production during July, corrected for seasonal variation, was the highest ever attained. The index of activity for the month, without correction for seasonal variation and referred to the average for the period 1923-25 as 100, was 120.2, against 116.4 in June, 119.0 in May and 110.6 for July last year. The present rate of general production is materially above the average for the summer period of previous years.

The index of activity in general industry for the country as a whole shows an average of 119.9 for the seven months of this year, against 115.7 for the same period in 1927.

The rate of operations in the automobile manufacturing plants, including parts, at present appears to be on a plane about 40 per cent higher than last year, with the average for the first seven months about 28 per cent above that for the same period in 1927. The ferrous and non-ferrous metal-working plants are also maintaining a high rate of operation, the July rate being about 21 per cent greater than in July of last year. In the metals group the July figure was only 1 per cent under the peak of February last.

Textiles showed a decline in the rate of operation. In July the industry operated at a rate about 19 per cent under that witnessed in July of last year, and the average for the first seven months was close to 12 per cent below that which obtained in the same period in 1927. The peak of 1928 activity in the textile industry was reached in February, and ever since that month the curtailment in operations has been constant and at a more than normal seasonal rate. The position of the industry in July was the lowest since July, 1926.

The rate of industrial activity in July, compared with July of last year, all figures adjusted to 26 working days and based on consumption of electrical energy as reported to *Electrical World* (monthly average 1923-25 equals 100) follows:

	July, 1928	July, 1927
All industrial groups	120.2	110.6
Metal industries group	124.2	108.6
Rolling mills and steel plants	121.2	113.0
Metal-working plants	126.3	104.4
Leather and its products	99.0	96.3
Textiles	91.8	113.0
Lumber and its products	108.8	112.9
Automobiles and parts	143.7	102.3
Stone, clay and glass	129.8	111.3
Paper and pulp	127.3	115.8
Rubber and its products	135.3	109.0
Chemicals and allied products	128.5	104.9
Food and kindred products	129.2	121.2
Shipbuilding	67.2	116.7

Temporary Decline in Lumber Movement

Temporary declines in production, shipments and orders characterized the lumber movement for the week ended Aug. 11, according to the National Lumber Manufacturers Association. Production for the week under review totaled 339,462,000 ft., shipments 354,667,000 ft. and orders 348,873,000 ft. There were nine fewer mills reporting than for the week before, which partly accounted for the declines.

Reports from the West indicate growing strength in the lumber industry of that section, these mills producing 185,624,638 ft. during the week, compared with an operating capacity of 217,985,757 ft., or a capacity production of 85 per cent.

Lumber Mills Consolidate for Operating Economy

The recent formation of a $10,000,000 holding company for consolidation of 75 per cent of the mills in Aberdeen, Hoquiam, Montesano and Cosmopolis, Wash., is said to be an effort to stabilize the lumber industry and associated industries of the Grays Harbor district. One of the leading lumber men involved states that the merger is expected to reduce the cost of lumber production and distribution, by making it possible for the mills to operate as associated units instead of business rivals. The grouping of the mills under a single management, he believes, will make it possible for them to operate on a continuous basis and to retain the present wage scale.